BS EN ISO 10893-1:2011

BSI Standards Publication

Non-destructive testing of steel tubes

Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leaktightness (ISO 10893-1:2011)

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National foreword

This British Standard is the UK implementation of EN ISO 10893-1:2011. It supersedes BS EN 10246-1:1996 and BS EN 10246-2:2000, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/110, Steel Tubes, and Iron and Steel Fittings.

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

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Non-destructive testing of steel tubes - Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leaktightness (ISO 10893-1:2011)

Essais non destructifs des tubes en acier - Partie 1: Contrôle automatisé électromagnétique pour vérification de l'étanchéité hydraulique des tubes en acier sans soudure et soudés (sauf à l'arc immergé sous flux en poudre) (ISO 10893-1:2011)

Zerstörungsfreie Prüfung von Stahlrohren - Teil 1: Automatisierte elektromagnetische Prüfung nahtloser und geschweißter (ausgenommen unterpulvergeschweißter) Stahlrohre zum Nachweis der Dichtheit (ISO 10893-1:2011)

This European Standard was approved by CEN on 10 December 2010.

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Foreword

This document (EN ISO 10893-1:2011) has been prepared by Technical Committee ISO/TC 17 "Steel" in collaboration with Technical Committee ECISS/TC 110 “Steel tubes, and iron and steel fittings” 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of an identical text or by endorsement, at the latest by October 2011, and conflicting national standards shall be withdrawn at the latest by October 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10246-2:2000, EN 10246-1:1996.

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Endorsement notice

The text of ISO 10893-1:2011 has been approved by CEN as a EN ISO 10893-1:2011 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10893-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes*.

This first edition cancels and replaces ISO 9302:1994, which has been technically revised.

ISO 10893 consists of the following parts, under the general title *Non-destructive testing of steel tubes*:

— *Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leaktightness*

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

— *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*

— *Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections*

— *Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

— *Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

— *Part 7: Digital radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

— *Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections*

— *Part 9: Automated ultrasonic testing for the detection of laminar imperfections in strip/plate used for the manufacture of welded 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*

— *Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections*

— *Part 12: Automated full peripheral ultrasonic thickness testing of seamless and welded (except submerged arc-welded) steel tubes*

Non-destructive testing of steel tubes —

Part 1: Automated electromagnetic testing of seamless and welded (except submerged arc-welded) steel tubes for the verification of hydraulic leaktightness

1 Scope

This part of ISO 10893 specifies requirements for automated electromagnetic testing of seamless and welded steel tubes, with the exception of submerged arc-welded (SAW) tubes, for verification of hydraulic leaktightness. It is applicable to the inspection of tubes with an outside diameter greater than or equal to 4 mm, when testing with eddy current, and greater than 10 mm when testing with flux leakage method.

This part of ISO 10893 can also be applicable to the testing of hollow sections.

NOTE Electromagnetic inspection using magnetic flux leakage method is not applicable to austenitic stainless steel tubes.

2 Normative references

The following referenced documents are indispensable for the application 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 9712, *Non-destructive testing — Qualification and certification of personnel*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11484 and the following apply.

3.1
reference standard
standard for the calibration of non-destructive testing equipment (e.g. drill holes, notches and recesses)

3.2
reference tube
tube or length of tube containing the reference standard(s)

3.3
reference sample
sample (e.g. segment of tube, plate or strip) containing the reference standard(s)

NOTE Only the term "reference tube" is used in this part of ISO 10893 also covering the term "reference sample".

3.4
tube
hollow long product open at both ends, of any cross-sectional shape

3.5
seamless tube
tube made by piercing a solid product to obtain a tube hollow, which is further processed, either hot or cold, into its final dimensions

3.6
welded tube
tube made by forming a hollow profile from a flat product and welding adjacent edges together, and which after welding can be further processed, either hot or cold, into its final dimensions

3.7
manufacturer
organization that manufactures products in accordance with the relevant standard(s) and declares the compliance of the delivered products with all applicable provisions of the relevant standard(s)

3.8
agreement
contractual arrangement between the manufacturer and purchaser at the time of enquiry and order

4 General requirements

4.1 Unless otherwise specified by the product standard or agreed on by the purchaser and manufacturer, an electromagnetic inspection shall be carried out on tubes after completion of all the primary production process operations (rolling, heat treating, cold and hot working, sizing, primary straightening, etc.).

4.2 The tubes being tested shall be sufficiently straight to ensure the validity of test. The surfaces shall be sufficiently free of foreign matter which can interfere with the validity of the test.

4.3 This inspection shall be carried out by trained operators qualified in accordance with ISO 9712, ISO 11484 or equivalent, and supervised by competent personnel nominated by the manufacturer. In the case of third-party inspection, this shall be agreed on between the purchaser and manufacturer.

The operating authorization issued by the employer shall be according to a written procedure. NDT operations shall be authorized by a level 3 NDT individual approved by the employer.

NOTE The definition of levels 1, 2 and 3 can be found in appropriate International Standards, e.g. ISO 9712 and ISO 11484.

5 Test method

5.1 Test techniques

5.1.1 Depending on the type of products, the dimensions, the type of steel used and its magnetic properties, the tubes shall be tested for the verification of hydraulic leaktightness by either the eddy current method or the flux leakage method, using one of the following automated or semi-automated techniques:

a) concentric coil technique (eddy current method) (see Figure 1);

b) segment coil technique (eddy current method) (see Figure 2);

c) fixed or rotating probe/pancake coil technique (eddy current method) (see Figure 3);

d) fixed or rotating magnetic transducer technique (flux leakage method) (see Figure 4);

e) multiple concentric magnetic transducers technique (flux leakage method) (see Figure 5).

For all techniques, the chosen relative speed of movement during the testing shall not vary by more than ±10 %.

NOTE 1 It is recognized that there can be, as in the case of hydraulic testing under normal production conditions, a short length at both tube ends which cannot be tested.

NOTE 2 See Annexes A and B for guidelines on the limitations of the eddy current test method and flux leakage test method.

5.1.2 When testing seamless or welded tubes using the eddy current concentric coil technique, the maximum tube outside diameter tested shall be restricted to 250 mm.

Square or rectangular tubes with a maximum dimension across the diagonal of 250 mm may also be tested using this technique with adequately shaped coils.

5.1.3 When testing tubes using the segment coils technique, the maximum tube outside diameter that shall be tested shall be limited to:

— ∅ 219,1 mm for 2 × 180° coils;

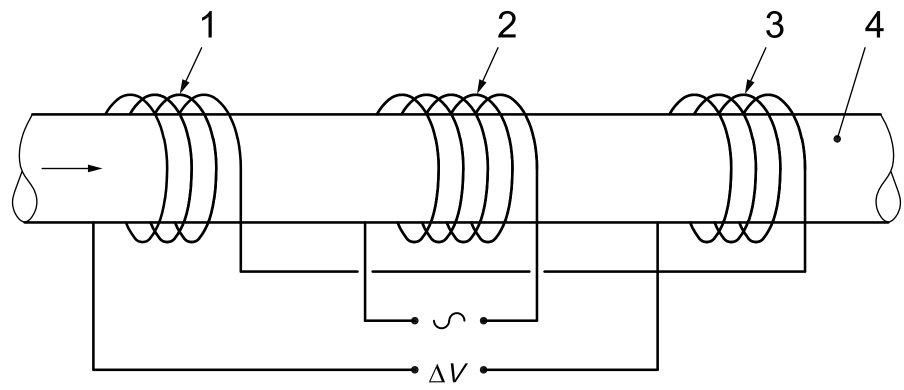
— ∅ 508,0 mm for 4 × 100° coils.

5.1.4 When testing seamless or welded tubes using the fixed or rotating probe/pancake coil eddy current technique or the fixed or rotating magnetic transducer flux leakage technique, the tube and the probes/pancake coils/magnetic transducer shall be moved relative to each other or the movement shall be simulated by electronic commutation through the individual probes composing the pancake, such that the whole of the tube surface is scanned with coverage calculated on the dimensions of probe/pancake coils and magnetic transducers. There is no restriction on the maximum outside diameter using these techniques.

5.1.5 When testing seamless and welded tubes using the multiple concentric magnetic transducer technique, the tube and the multiple transducer assembly shall be linearly moved relative to each other such that the whole of the tube surface is scanned with coverage calculated on the dimensions of probe/pancake coils and magnetic transducers. There is no restriction on the maximum outside diameter using this technique.

5.2 Test equipment

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



Key

1 secondary coil 1

2 primary coil

3 secondary coil 2

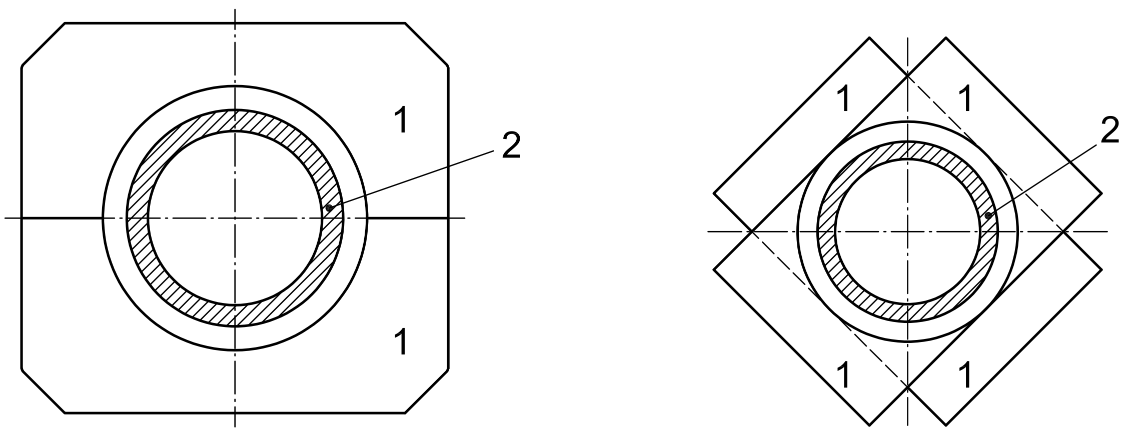
4 tube

~ alternate energizing current

ΔV signal output

NOTE The above diagram is a simplified form of a multi-coil arrangement which can contain, for example split primary coils, twin differential coils and calibrator coil.

Figure 1 — Simplified diagram of eddy current concentric coil technique



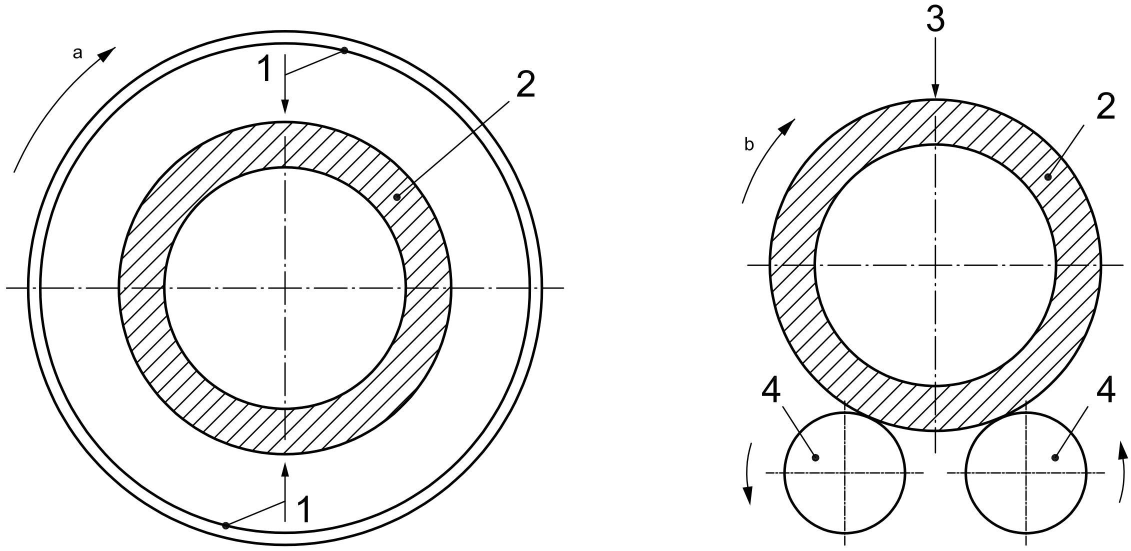
a) 2 × 180° **segment coils** **b)** 4 × 100° **segment coils**

Key

1 segment coil

2 tube

Figure 2 — Simplified diagram of eddy current segment coil technique



a) Rotating probe/pancake coil technique — Linear movement of the tube

b) Fixed probe/pancake coil technique — Linear and rotary movement of the tube

Key

1 position of probe/pancake coil

2 tube

3 position of fixed pancake coil

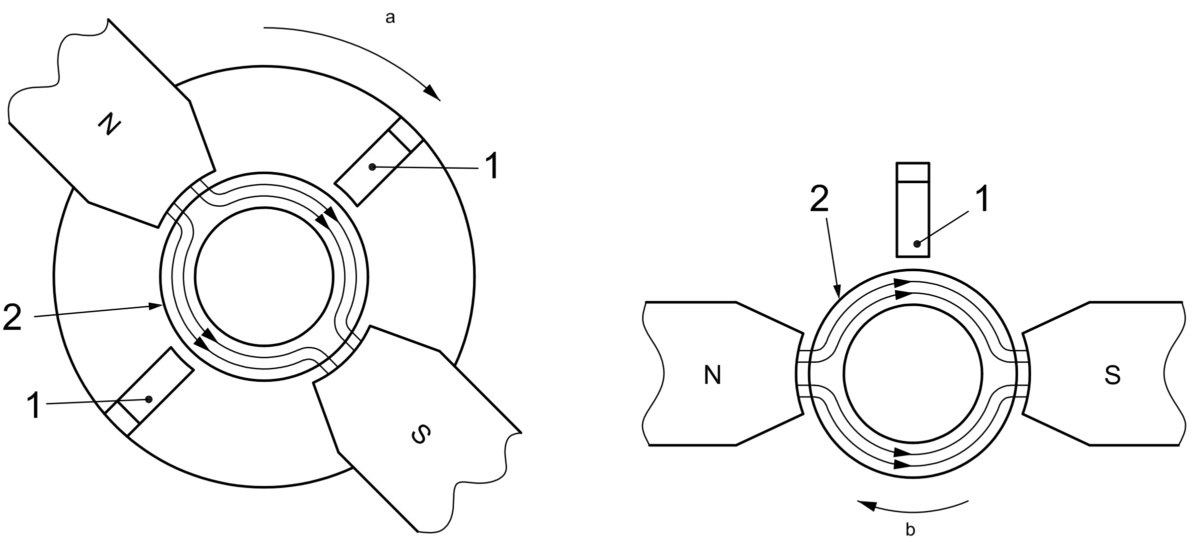
4 rollers

a Direction of probe rotation.

b Direction of tube rotation.

NOTE The pancake coils in a) and b) can have different forms, e.g. single-coils, multiple coils of different configurations, depending on the equipment used and other factors.

Figure 3 — Simplified diagram of probe/pancake coil eddy current technique



a) Rotating magnetic transducer technique — Linear movement of the tube

b) Fixed magnetic transducer technique — Linear and rotary movement of the tube

Key

1 flux leakage transducers

2 tube

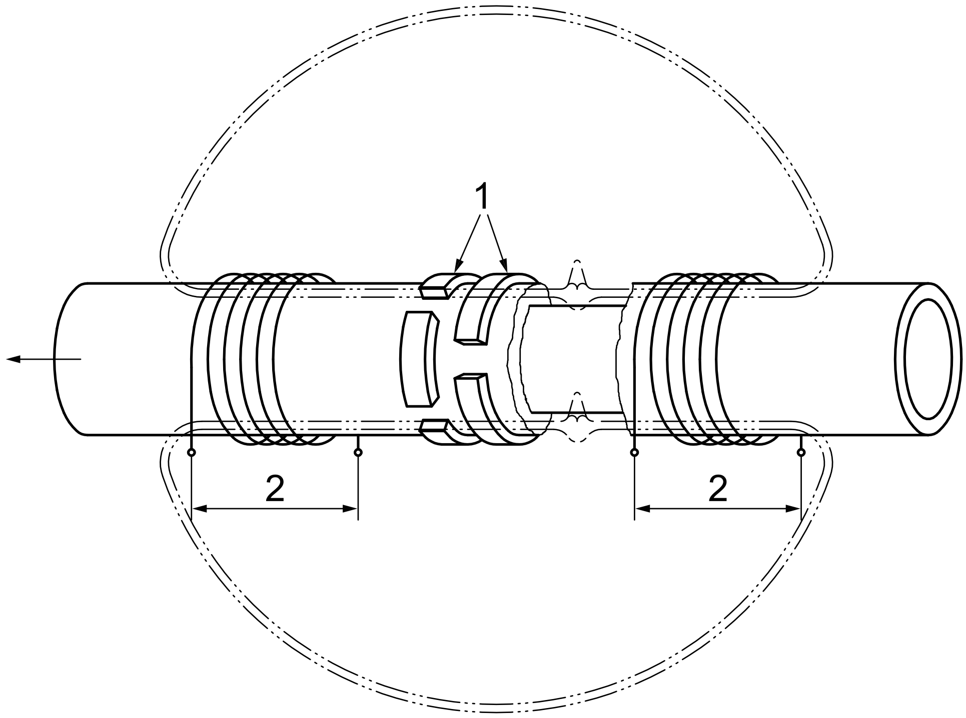
N magnetic north pole

S magnetic south pole

[a] Direction of probe rotation.

[b] Direction of tube rotation.

Figure 4 — Simplified diagram of magnetic flux leakage technique for the detection of longitudinal imperfections



Key

1 staggered array of transducers

2 magnetic saturation coils (d.c.)

NOTE The magnetic transducers can take different forms, for example absolute and differential, depending on the equipment used and other factors. The means of introducing magnetic flux in a direction parallel to the major axis of the tube can be achieved by methods other than that shown in this figure.

Figure 5 — Simplified diagram of magnetic flux leakage technique for the detection of transverse imperfections

6 Reference tube

6.1 General

6.1.1 The reference standards defined in this part of ISO 10893 are convenient standards for the 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.

6.1.2 The reference tubes shall have the same specified diameter and thickness, same surface finish, delivery condition (e.g. as-rolled, normalized, quenched and tempered) and similar steel grade as the tubes under test. For specified wall thickness exceeding 10 mm, the wall thickness of the reference tubes may be greater than the specified wall thickness of the pipe being inspected, provided the notch depth is calculated on the specified wall thickness of the pipe being inspected. The manufacturer shall demonstrate, on request, the effectiveness of the adopted solution.

6.1.3 The reference standards used for the various testing techniques shall be as follows:

a) a reference hole or holes as defined in 6.2 and 6.6.1, when using the eddy current concentric coil and as defined in 6.3 and 6.6.1, when using segment coil technique;

b) a reference longitudinal notch, as defined in 6.4 and 6.6.2, when using one of the following techniques:

   1) fixed or rotating probe/pancake coil eddy current technique;

   2) fixed or rotating magnetic transducer flux leakage technique.

c) a reference transverse notch, as defined in 6.5 and 6.6.2, when using the multiple concentric magnetic transducer flux leakage technique;

d) by agreement between the purchaser and manufacturer, the reference holes suggested in Table 1 may also be used when flux leakage inspection technique is performed.

NOTE 1 For eddy current testing, concentric coil, segment coil, fixed or rotating probe/pancake coil, other types of reference standard which shows the same characteristics can be used by agreement between the purchaser and manufacturer.

NOTE 2 In special cases, for example testing hot tubes or using equipment contained within a continuous tube mill, a modified calibration or calibration checking procedure can be used, by agreement. Also by agreement, internal longitudinal or transverse notches can be additionally used during flux leakage inspection of pipes having wall thickness lower than 12,7 mm.

6.1.4 The reference standards (see 6.2 to 6.5) shall be sufficiently separated longitudinally (in the case of reference holes) and from the ends of the reference tube such that clearly distinguishable signal indications are obtained.

6.2 Eddy current concentric coil technique

6.2.1 When using the eddy current concentric coil technique, the reference tube shall contain three or four circular holes, drilled radially through the full thickness of the reference tube. The holes shall be circumferentially displaced respectively at 120° or 90° from each other.

6.2.2 Alternatively, only one hole shall be drilled through the full thickness of the reference tube and during calibration and calibration checking the reference tube shall be passed through the equipment with the hole positioned at 0°, 90°, 180° and 270°.

6.3 Eddy current segment coil technique

6.3.1 When using the segment coil technique, the reference tube shall contain three circular holes, drilled radially through the full thickness of the reference tube. Each segment coil shall be checked with the reference tube, and the three holes shall be displaced as follows:

— 180° segment coils: 0°, +90° and –90° from the centre of the coil;

— 100° segment coils: 0°, +45° and –45° from the centre of the coil.

6.3.2 Alternatively, only one hole shall be drilled through the full thickness of the reference tube and during calibration and calibration checking the reference tube shall be passed through the equipment with the hole positioned at 0°, +90° and –90° for the 180° segment coil and at 0°, +45° and –45° for the 100° segment coil. These operations shall be repeated for each segment coil.

6.4 Eddy current and flux leakage rotating techniques

6.4.1 When using the fixed or rotating probe/pancake coil eddy current technique, the reference tube shall contain a longitudinal reference notch on the external surface.

6.4.2 When using the fixed or rotating magnetic transducer flux leakage technique, the reference tube shall contain a longitudinal reference notch on the external surface or, by agreement, a reference hole as listed in Table 1. In this case, the manufacturer shall demonstrate that the test sensitivity achieved using the reference hole and the equipment settings, for example signal rate filtering, is essentially equivalent to that obtained when using the reference notch.

6.5 Flux leakage — multiple transducer technique

When using the multiple magnetic transducer flux leakage technique, the reference tube shall contain a transverse reference notch on the external surface of the reference tube or, by agreement, a reference hole as listed in Table 1.

6.6 Dimensions of the reference standards

6.6.1 Reference hole

The diameter of the reference holes related to the tube outside diameter shall not exceed the requirements of Table 1; the holes shall be formed by machining, spark erosion or other methods.

Table 1 — Specified tube diameter related to the diameter of the reference holes

Specified tube outside diameter D mm	**Maximum hole diameter** Acceptance level mm
$4 \leqslant D \leqslant 15{,}8$	1,20
$15{,}8 < D \leqslant 26{,}9$	1,40
$26{,}9 < D \leqslant 48{,}3$	1,70
$48{,}3 < D \leqslant 63{,}5$	2,20
$63{,}5 < D \leqslant 114{,}3$	2,70
$114{,}3 < D \leqslant 139{,}7$	3,20
$139{,}7 < D$	3,70

For those products requesting a more severe inspection, e.g. for stainless steel pipes, by agreement between the customer and manufacturer, Table 2 may be adopted.

Table 2 — Specified tube diameter related to the diameter of the reference holes

Specified tube outside diameter D mm	**Maximum hole diameter** Acceptance level mm
$4 \leqslant D \leqslant 15{,}8$	1,00
$15{,}8 < D \leqslant 26{,}9$	1,20
$26{,}9 < D \leqslant 48{,}3$	1,40
$48{,}3 < D \leqslant 63{,}5$	1,70
$63{,}5 < D \leqslant 114{,}3$	2,20
$114{,}3 < D \leqslant 139{,}7$	2,70
$139{,}7 < D$	3,20

6.6.2 Reference notch

6.6.2.1 General

a) The reference notch shall be of the “N” type (see Figure 6) and shall lie

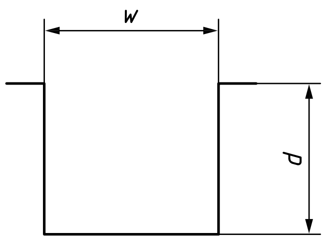
1) parallel to the major axis of the tube for tests in accordance with 5.1.1 c) and d) (see also 6.4), or

2) at right angles to the major axis of the tube for tests in accordance with 5.1.1 e) (see Figure 7 and also 6.5).

The sides shall be nominally parallel and the bottom shall be nominally square to the sides.

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

NOTE The bottom or the bottom corners of the notch can be rounded.



Key
w width
d depth

Figure 6 — “N” type notch

6.6.2.2 Dimensions of the reference notch

a) Width, w (see Figure 6)

The width of the reference notch shall be not greater than the reference notch depth or 1 mm whichever is greater.

b) Depth, d (see Figures 6 and 7)

The depth of the reference notch shall be 12,5 % of the specified thickness with the following limitations:

1) minimum notch depth: 0,5 mm;

2) maximum notch depth: 1,5 mm.

The tolerance on notch depth shall be ±15 % of reference notch depth.

c) Length

Unless otherwise specified by product standard or agreed between the purchaser and manufacturer, the length of the reference notch(es) shall be greater than twice the width of each individual probe/pancake coil or transducer. In any case, the length of reference notch shall not exceed 50 mm.

a) External partial circumferential notch **b) Chord notch — External only**

Key

d depth

Figure 7 — Possible transverse notch forms

6.6.3 Verification of the reference standards

6.6.3.1 The diameter of the reference hole(s) (see Table 1), when used, shall be verified and shall not exceed the value reported in Table 1.

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

7 Equipment calibration and checking

7.1 At the start of each inspection cycle, the equipment shall be calibrated to consistently produce (e.g. from three consecutive passes of the reference tube through the equipment) clearly identifiable signals from the reference standard(s). These signals shall be used to activate their respective trigger alarm of the equipment.

7.2 When using multiple reference holes in the reference tube (eddy current concentric coil or segment coils technique), the full amplitude obtained from the reference hole giving the smallest signal shall be used to set the trigger/alarm level of the equipment. When using a single reference hole in the sample test pipe, the sample test pipe shall be passed through the inspection equipment with the reference hole, on successive runs positioned as requested in 6.2.2 or 6.3.2; the full amplitude of the smallest signal obtained from the reference hole shall be used to set the trigger/alarm level of the equipment.

7.3 When using the reference notch (fixed or rotating probe/pancake coil eddy current technique or fixed or rotating magnetic transducer flux leakage technique), the full signal amplitude shall be used to set the trigger/alarm level of the equipment.

7.4 When using the partial circumferential notch, chord reference notch or the reference hole (multiple transducer flux leakage technique), the reference tube shall be passed through the inspection equipment with the reference notch or hole, on successive runs, positioned at the angular pitch of adjacent magnetic transducers, such that the centre of the reference notch or hole passes past the centre line of each transducer in turn. The full signal amplitude obtained from each transducer shall be used to set the trigger/alarm level on the transducer channel of the equipment.

7.5 During dynamic checking of calibration, the relative speed of movement between the reference tube and the test coils shall be the same as that used during the production test (see 5.1.2, 5.1.4 and 5.1.5). The same equipment settings, for example frequency, sensitivity, phase discrimination, filtering and magnetic saturation, shall be employed.

7.6 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 reference tube through the equipment.

The frequency of checking the calibration shall be at least every 4 h, but also whenever there is an equipment operator changeover and at the start and end of the production run.

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

7.8 If on checking during production testing, the calibration requirements are not satisfied then all tubes tested since the previous acceptable equipment calibration shall be retested after the equipment has been recalibrated.

8 Acceptance

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

8.2 Any tube producing signals equal to or greater than the trigger/alarm level shall be designated suspect or, at the discretion of the manufacturer, may be retested. If after two consecutive retests all signals are lower than the trigger/alarm level, the tube shall be deemed to have passed this test otherwise the tube shall be designated as suspect.

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

b) Each suspect tube shall be subjected to a hydraulic leaktightness test in accordance with the relevant product standard, unless otherwise agreed between the purchaser and manufacturer.

c) The suspect area shall be cropped off.

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

9 Test report

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

a) reference to this part of ISO 10893, i.e. ISO 10893-1;

b) statement of conformity;

c) any deviation, by agreement or otherwise, from the procedures specified;

d) product designation by steel grade and size;

e) type and details of inspection technique(s);

f) equipment calibration method used;

g) description of the reference standard acceptance level;

h) date of test;

i) operator identification.

Annex A
(informative)

Guidance notes on limitations of eddy current test method

A.1 Eddy current depth of penetration

During the eddy current testing of tubes, the sensitivity of the test is at a maximum at the tube surface adjacent to the test coil and decreases with increasing distance from the test coil. The signal response from a subsurface or internal surface imperfection is thus smaller than that from an external surface imperfection of the same size. The capacity of the test equipment to detect subsurface or internal surface imperfections is determined by various factors, but predominantly by the thickness of the tube under test and the eddy current excitation frequency.

The excitation frequency applied to the test coil determines the extent to which the induced eddy current intensity penetrates the tube wall. The higher the excitation frequency, the lower the penetration and conversely, the lower the excitation frequency, the higher the penetration. In particular, the physical parameters of the tube (conductivity, permeability, etc.) should be taken into account.

A.2 Concentric coil/segment coil technique

These test techniques are preferred since they can detect short longitudinal imperfections and transverse imperfections, both of which break, or lie below, the surface adjacent to the test coil.

The minimum length of the longitudinal imperfection which is detectable is principally determined by the search coil arrangement and by the rate of change of section along the length of the imperfection.

When using this technique on ferromagnetic steel, the products under inspection shall be magnetically saturated inserting them into an external strong magnetic field. The intention of this saturation is to normalize and reduce the magnetic permeability of the material in order to increase the penetration capability of eddy current and reduce possible magnetic noises from material itself.

A.3 Fixed or rotating probe/pancake coil technique

This test technique uses one or more probes/coils to describe a helical path over the tube surface. For this reason, this technique detects longitudinal imperfections with a minimum length dependent on the width of the test coil and the inspection helical pitch. It is recognized that transverse imperfections are not normally detectable.

Since the excitation frequency is significantly higher than that using concentric coil/segment coil, only imperfections which break the tube surface adjacent to the test coil are detectable.

Annex B
(normative)

Limitations of magnetic flux leakage test method

B.1 General

When using this method the products under inspection shall be magnetically saturated by inserting them in an external strong magnetic field; the aim of this saturation is to cause flux leakage/flux diversion from imperfections.

During the flux leakage testing of tubes, the sensitivity of the test is at a maximum at the tube surface adjacent to the magnetic transducer and decreases with increasing tube thickness due to effective diminishing flux diversion from imperfections at the tube bore surface in relation to that at the external surface. The signal response from internal surface imperfections can thus be smaller than that from an external imperfection of the same size.

B.2 Fixed or rotating magnetic transducer

These test techniques use one or more magnetic transducers to describe a helical path over the tube surface. For this reason, these techniques detect longitudinal imperfections with a minimum length dependant on the width of the transducer and the inspection helical pitch. It is recognized that transverse imperfections are not normally detectable.

B.3 Multiple transducers technique

This test technique uses multiple fixed magnetic transducers surrounding the tube during its linear movement. For this reason, the technique detects predominantly transverse imperfections having a minimum length dependant on the circumferential dimension of the transducer. It is recognized that longitudinal imperfections are not normally detectable unless they have a significant transverse component (oblique).

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