INTERNATIONAL STANDARD

ISO 10893-1

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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

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)

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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;

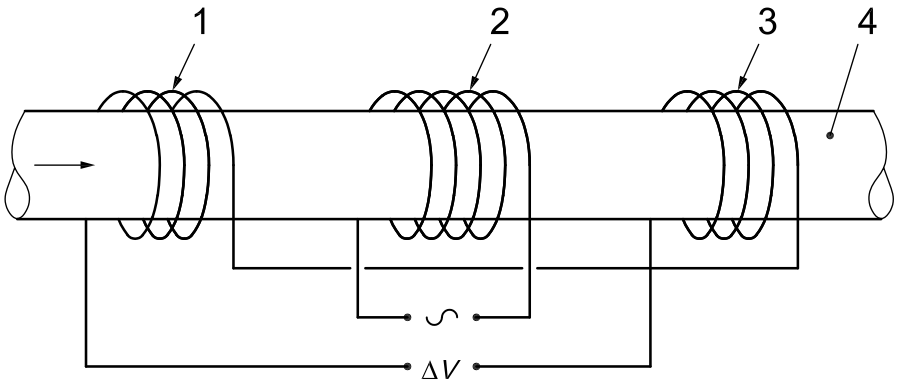
— ∅ 508,0 mm for 4 × 100° coils.

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.

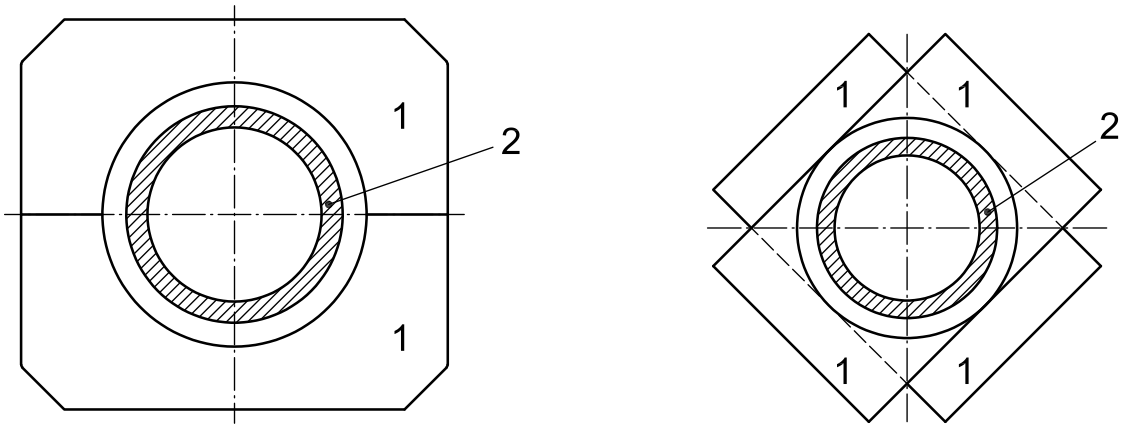


Key

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

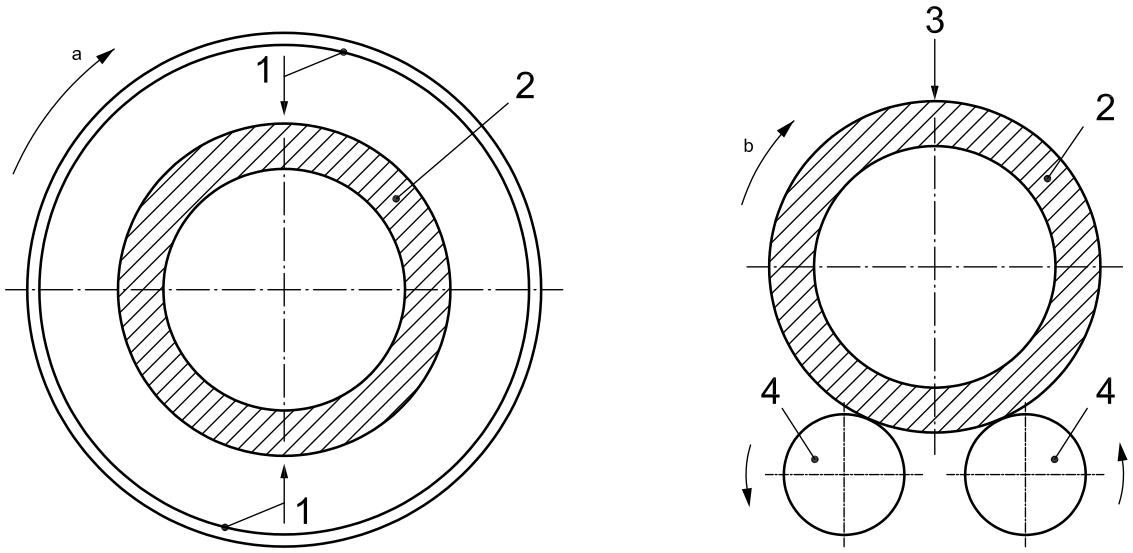


a) 2 × 180° **segment coils** **b)** 4 × 100° **segment coils**

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