INTERNATIONAL STANDARD

ISO 10893-12

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Non-destructive testing of steel tubes —

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

Essais non destructifs des tubes en acier —

Partie 12: Contrôle automatisé de l'épaisseur par ultrasons sur toute la circonférence des tubes en acier sans soudure et soudés (sauf à l'arc immergé sous flux en poudre)

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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 10893-12 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 10543:1993, 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 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 12: Automated full peripheral ultrasonic thickness testing of seamless and welded (except submerged arc-welded) steel tubes

1 Scope

This part of ISO 10893 specifies requirements for the automated full peripheral ultrasonic testing of seamless and welded steel tubes, with the exception of submerged arc-welded (SAW) tubes, for wall thickness measurement. It specifies the testing method and corresponding calibration procedures.

NOTE 1 Full peripheral testing does not necessarily mean that 100 % of the tube surface is scanned.

NOTE 2 This test can be carried out simultaneously with full peripheral ultrasonic testing for the detection of laminar imperfections (see ISO 10893-8) using the same ultrasonic transducers for both inspection requirements. Under these circumstances, the minimum lamination size under detection determines the percentage of the tube surface for scanning, according to ISO 10893-8.

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

This part of ISO 10893 is applicable to the thickness measurement of tubes with a specified outside diameter equal to or greater than 25,4 mm and a minimum wall thickness of 2,6 mm, unless otherwise agreed on.

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 5577, *Non-destructive testing — Ultrasonic inspection — Vocabulary*

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 5577 and ISO 11484 and the following apply.

3.1
reference tube
tube or length of tube used for calibration purposes

3.2
reference sample
sample (e.g. segment of tube, plate or strip) used for calibration purposes

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

3.3
tube
hollow long product open at both ends, of any cross-sectional shape

3.4
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

3.5
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

3.6
electric welded tube
tube made by pressure welding, in a continuous or non-continuous process, in which strip is formed cold into a hollow profile and the seam weld made by heating the adjacent edges through the resistance to the passage of high- or low-frequency current, and pressing the edges together

NOTE The electric current can be applied either by direct electrode contact or by induction.

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 between purchaser and manufacturer, an ultrasonic test shall be carried out on tubes after completion of all the primary production process operations (rolling, heat treating, cold and hot working, sizing and primary straightening, etc.).

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

4.3 This test shall be carried out by suitably 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 by the purchaser and manufacturer.

The operating authorization issued by the employer shall be according to a written procedure. Non-destructive testing (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 The tube shall be tested using the ultrasonic single or multiple pulse echo technique, with piezoelectric or electromagnetic transducers. The ultrasound shall be transmitted in the direction normal to the tube surface, to determine that the tube thickness meets the specified requirements.

5.2 During testing, the tubes and the probe assembly shall be moved relative to each other such that (with the exception provided in Note 2 of Clause 1) the tube surface shall be scanned over equidistant non-coincident helical paths along the entire length of the tube. Unless specified in the product standards or agreed on by the manufacturer and purchaser, the minimum coverage shall be at the manufacturer's discretion according to his manufacturing process, but shall be not less than 10 % of the surface area.

NOTE Other scanning routes can be used by agreement between the purchaser and manufacturer.

5.3 The suggested maximum width of each transducer, or each active aperture when using phased array transducers, should be 25 mm measured in any direction. However, manufacturers may use larger transducers provided they can demonstrate their capability for detecting the adopted reference standard; on request, this capability shall be demonstrated.

5.4 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 recording and/or sorting system.

6 Reference tube

6.1 The reference tube (or partly scanned tube) shall have the same nominal diameter and thickness, same surface finish, heat treatment and delivery condition (e.g. as-rolled, normalized, quenched and tempered) as the tubes under test, and shall have similar acoustic properties (e.g. sound velocity and attenuation coefficient).

6.2 The reference tube (or machined reference sample or machined block or hollow bar of steel) shall, at the manufacturer's discretion, either

a) have a known area with a predetermined thickness with an accuracy better than ±0,1 mm, or

b) have a machined section(s) either at the specified minimum thickness or having one section at minimum thickness and one section between minimum and maximum thickness limits. The thickness of the reference tube used for calibrating the ultrasonic equipment shall have a tolerance of ±0,05 mm or ±0,2 %, whichever is the greater.

7 Equipment calibration and checking

7.1 At the start of each test cycle, the equipment shall be calibrated statically using the selected reference tube such that it indicates the thickness of the reference tube with an accuracy better than ±0,10 mm or ±2 %, whichever is the greater, such that a trigger/alarm condition is produced whenever the specified thickness limit(s) is exceeded.

The manufacturer shall demonstrate that the results achieved during the production testing are consistent with those achieved at the static calibration.

7.2 During the production testing of the tubes, the relative rotational and translational speeds shall be chosen such that the tube surface is scanned in accordance with 5.2. Relative speed of movement during testing shall not vary by more than ±10 %.

7.3 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 4 h, but also whenever there is an equipment operator team changeover and at the start and end of production.

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

7.5 If, on checking during production testing, the calibration requirements are not satisfied even after taking into account an additional accuracy tolerance given in 7.6, all the tubes tested since the previous check shall be retested after the equipment has been recalibrated.

7.6 To allow for system drift, an additional thickness accuracy tolerance of +1 % or +0,05 mm, whichever is the greater in excess of that stated in 7.1, shall be taken into account during checking of the equipment calibration during production testing.

7.7 By agreement between the manufacturer and the purchaser, it shall be demonstrated that at the advancing and/or rotating speed and pulse repetition frequency used, the equipment is capable of detecting a non-conforming thickness.

8 Acceptance

8.1 Any tube producing no trigger/alarm condition (see 7.1) shall be deemed to have passed this test.

8.2 Any tube producing a trigger/alarm condition (see 7.1) shall be designated suspect or, at the manufacturer's discretion, 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) If the manufacturer can prove that the trigger/alarm condition arises from a combination of minor imperfections, e.g. inclusion clusters, not individually or in combination extensive enough to cause rejection, the tube shall be deemed to have passed the test.

b) If applicable, the suspect area of the tube exhibiting thickening in excess of the upper tolerance limit may be dressed by a suitable method. After checking that the remaining wall thickness is within the specified tolerances, the tube shall be deemed to have passed the test.

c) The suspect area shall be cropped off.

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

9 Test report

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

a) reference to this part of ISO 10893, i.e. ISO 10893-12;

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 the test technique(s);

f) equipment calibration method used;

g) description of the reference standard;

h) date of test;

i) operator identification.