INTERNATIONAL STANDARD

ISO

13663

Welded steel tubes for pressure purposes — Ultrasonic testing of the area adjacent to the weld seam for the detection of laminar imperfections

Tubes en acier soudés pour service sous pression — Contrôle par ultrasons de la zone adjacente au cordon de soudure pour la détection des dédoublures de laminage

ISO

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.

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.

International Standard ISO 13663 was prepared by Technical Committee ISO/TC 17, *Steel,* Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes.*

Introduction

This International Standard concerns ultrasonic testing of the area adjacent to the weld seam of welded steel tubes for pressure purposes, for the detection of laminar imperfections.

Three different acceptance levels are considered (see table 1). The choice between these acceptance levels is within the province of the ISO Technical Committee responsible for the development of the relevant quality standards.

Welded steel tubes for pressure purposes — Ultrasonic testing of the area adjacent to the weld seam for the detection of laminar imperfections

1 Scope

1.1 This International Standard specifies requirements for ultrasonic testing of the area adjacent to the weld seam of welded steel tubes for pressure purposes, for the detection of laminar imperfections, according to three different acceptance levels (see table 1).

It is intended this International Standard be used to detect, over a zone parallel and adjacent to the weld seam, laminar imperfections which may interfere with the integrity of the weld seam and/or the ultrasonic inspection of the weld seam for detection of imperfections.

NOTE 1   This inspection may alternatively be carried out on the longitudinal edges of strip/plate (used in the manufacture of welded tubes), in the flat form prior to seam welding in accordance with ISO 12094.

1.2 This International Standard covers the inspection of welded tubes with an outside diameter greater than 30 mm. No lower limit of tube thickness is specified, but see note 2.

NOTE 2   For thicknesses less than 5 mm, difficulties can be experienced in detecting and sizing laminar imperfections by this method. When such difficulties arise, agreement between the purchaser and manufacturer is required to determine the testing technique to be adopted.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11484:1994, *Steel tubes for pressure purposes — Qualification and certification of non-destructive testing (NDT) personnel.*

ISO 12094:1994, *Welded steel tubes for pressure purposes — Ultrasonic testing for the detection of laminar imperfections in strips/plates used in the manufacture of welded tubes.*

ISO 12096:—[1], *Submerged arc-welded steel tubes for pressure purposes — Radiographic testing of the weld seam for the detection of imperfections.*

3 General requirements

3.1 The ultrasonic inspection covered by this International Standard may be performed on tubes at any stage in the production process after seam welding.

This inspection shall be carried out by personnel certificated in accordance with ISO 11484, as nominated by the manufacturer. In the case of third-party inspection, this shall be agreed between the purchaser and manufacturer.

3.2 The tubes to be tested shall be sufficiently straight to ensure the validity of the test. The surfaces of the area to be tested, adjacent to the weld seam, shall be sufficiently free from foreign matter which would interfere with the validity of the test.

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1)   To be published.

4 Method of test

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

4.2 During testing, the tube and/or 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 at the external surface, 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.

Table 1 — Minimum laminar imperfection length l_{min} (parallel to the weld) to be detected in the area adjacent to the weld (trigger/alarm condition)

Acceptance level	Minimum length of laminar imperfections, l_{min} mm
E1	10
E2	20
E3	30

NOTE 3 It is recognized that there may be a short length at both tube ends which cannot be tested. In this case, the manufacturer shall either crop off the untested length or apply a manual ultrasonic compression wave test to the area adjacent to the weld over the untested length using the same ultrasonic parameters as on the tested length, together with the appropriate acceptance limits.

4.3 The maximum dimension of each individual transducer, measured parallel to the major axis of the tube, shall be 30 mm. The minimum ultrasonic test frequency shall be 2 MHz (nominal).

4.4 The equipment for automatic testing shall be capable of differentiating between acceptable and suspect tubes by means of an automatic trigger/alarm level, combined with a marking and/or sorting system.
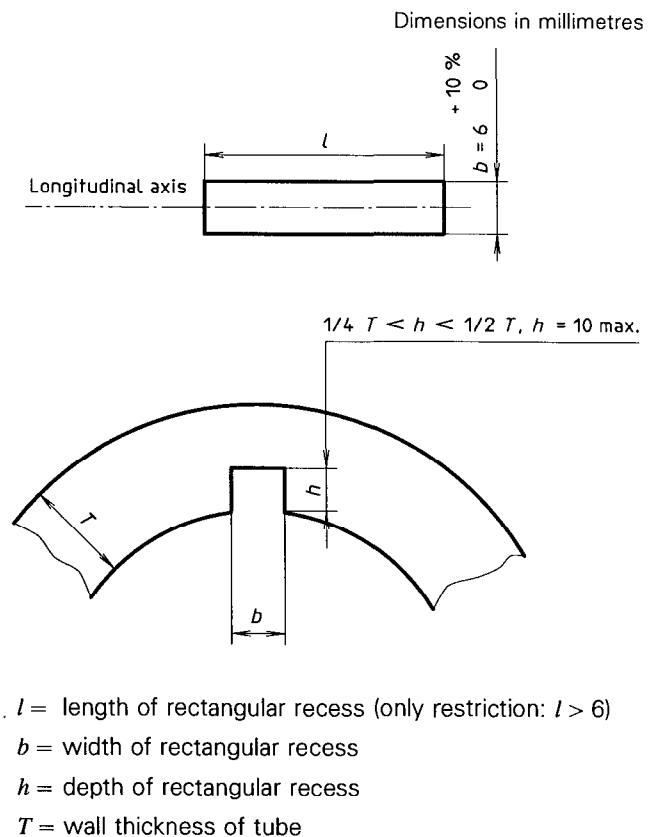
5 Reference standards

5.1 The reference standards defined in this International Standard 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.

5.2 The ultrasonic equipment shall be calibrated either electronically with a plain tubular test piece (see 7.1.1) or using a reference standard comprising a flat-bottomed round or rectangular recess (see figure 1) machined into the inner surface of a tubular test piece (see 7.1.2).

The reference standard with a flat-bottomed round recess shall be used as the primary means of establishing the test sensitivity. When using the rectangular recess, the test sensitivity shall be adjusted, if necessary, so that it is equivalent to that obtained when using the flat-bottomed round recess.

5.3 The test piece shall have 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, etc.).

$l =$ length of rectangular recess (only restriction: $l > 6$)

$b =$ width of rectangular recess

$h =$ depth of rectangular recess

$T =$ wall thickness of tube

Figure 1 — Reference recess forms

6 Dimensions of reference standards

6.1 The dimensions of the reference standard with a rectangular recess, when used, shall be as follows (see figure 1):

6.1.1 Width, b (circumferential dimension)

6 mm $^{+10}_{0}$ %

6.1.2 Length, l

Any convenient length, selected by the manufacturer.

6.1.3 Recess depth, h

Between 1/4 and 1/2 of the nominal tube thickness, with a maximum of 10 mm.

6.2 The dimensions of the reference standard with a round recess, when used, shall be as follows:

6.2.1 Diameter

6 mm $^{+10}_{0}$ %

6.2.2 Recess depth, h

Between 1/4 and 1/2 of the nominal tube thickness, with a maximum of 10 mm.

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

7 Equipment calibration and checking

7.1 The equipment shall be calibrated statistically using either electronic means in accordance with 7.1.1 or using a reference standard in accordance with 7.1.2.

7.1.1 Calibration using the electronic technique

With the transducer assembly positioned on the tubular 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.

At the start of the production testing run, the manufacturer shall demonstrate that, at the set test sensitivity, the equipment will detect, under static conditions, the flat-bottomed reference standard with a round recess as given in 5.2 and figure 1. If not, the necessary adjustment in test sensitivity shall be made prior to the testing of production tubes.

7.1.2 Calibration using the reference standard

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

7.2 During the production testing of tubes, the relative translational speeds, together with the equipment 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.

7.3 The calibration of the equipment shall be checked at regular intervals during the production testing of tubes of the same diameter, thickness and grade.

The frequency of checking the equipment calibration shall be at least every 4 h or once every ten production tubes tested, whichever is the longer time period, but also whenever there is an equipment operator team change-over and at the start and end of the production run.

NOTE 4   In cases where a production testing run is continuous from one shift period to the next, the 4 h maximum period may be extended by agreement between the purchaser and manufacturer.

7.4 The equipment shall be recalibrated following any system adjustments or whenever there is a change in the specified nominal tube diameter, wall thickness, or acoustic properties of the tube to be tested.

7.5 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.

Retesting shall not be necessary even after a drop in test sensitivity of more than 3 dB but less than 6 dB since the previous calibration, provided that suitable recordings from individually identifiable tubes are available which permit accurate classification into suspect and acceptable categories.

8 Acceptance

8.1 Any tube not producing a trigger/alarm condition shall be deemed to have passed this test.

8.2 Any tube producing a trigger/alarm condition shall be designated suspect or, at the manufacturer's option, may be retested as specified above.

8.3 If, on retesting, no trigger/alarm condition is obtained, the tube shall be deemed to have passed this test. Tubes producing a trigger/alarm condition shall be designated suspect.

8.4 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, in the area adjacent to the weld, shall be explored by a manual ultrasonic compression wave method, or by a suitable automatic or semi-automatic system, to establish the extent of the laminar imperfection using, if necessary, the 6 dB drop technique. The tube shall be deemed to have passed this test if the laminar imperfection size E_{max}, l_{max} and maximum population density, as given in table 2, are not exceeded.

b) In the case of spiral and longitudinal submerged arc-welded tubes, and by agreement between the 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 ISO 12096 to disclose the presence of imperfections in or at the extremities of the weld seam which may have escaped detection, during ultrasonic weld seam inspection, due to the presence of such laminar imperfections.

c) The suspect area shall be cropped off. The manufacturer shall ensure to the satisfaction of the purchaser that all the suspect area has been removed.

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 International Standard;

b) date of the test report;

c) acceptance level;

d) statement of conformity;

e) material designation by grade and size;

f) type and details of the inspection equipment;

g) description of the reference standard;

h) equipment calibration method used.

Table 2 — Acceptance limits

Acceptance level	Maximum individual lamination size[1]			Maximum population density of laminations[2] with $l_{min} < l < l_{max}$ and $E < E_{max}$ per metre length of tube
	Length		Product of longitudinal and transverse dimensions, E_{max} mm²	
	l_{min} [3] mm	l_{max} mm		
E1	10	20	250	3
E2	20	40	500	4
E3	30	60	1 000	5

1) 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.

2) Only laminar imperfections exceeding 6 mm in width (circumferential dimension) are to be considered.

3) To be detected.

ICS 23.040.10; 77.040.20; 77.140.30