INTERNATIONAL STANDARD

ISO 10124

First edition
1994-12-15

Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Ultrasonic testing for the detection of laminar imperfections

Tubes en acier sans soudure et soudés (sauf soudés à l'arc sous flux) pour service sous pression — Contrôle par ultrasons pour la détection des dédoublures

Reference number
ISO 10124:1994(E)

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 10124 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes.*

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Introduction

This International Standard concerns ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of laminar imperfections.

The term "laminar imperfection" means any imperfection lying essentially parallel to the tube surface, within the thickness of the product.

Four 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 product standards.

Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Ultrasonic testing for the detection of laminar imperfections

1 Scope

1.1 This International Standard specifies requirements for ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of laminar imperfections, according to four different acceptance levels. The acceptance level B1 is applicable only to seamless tubes intended for certain critical applications such as steam headers (see table 1).

NOTE 1 In the case of welded (except submerged arc-welded) tubes, an alternative ultrasonic testing specification is available for the detection of laminar imperfections, by ultrasonic testing of the steel strip prior to tube forming in accordance with ISO 12094.

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

NOTE 2 For wall 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 together with the laminar imperfection sizing method.

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

3 General requirements

3.1 The ultrasonic inspection covered by this International Standard is usually carried out on tubes after completion of all the primary production process operations.

These activities shall be carried out by personnel certified 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 shall be sufficiently free from foreign matter which would interfere with the validity of the test.

4 Method of test

4.1 The tubes 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.

1) To be published.

4.2 During testing, the tubes and/or the transducer assembly shall be moved relative to each other so that the tube surface is scanned, in order to detect laminar imperfections with a size equal to or greater than the relevant minimum laminar imperfection size (B_{min}) with a circumferential dimension (C) calculated from the formula given in table 1.

Table 1 — Acceptance levels and size of laminar imperfections to be detected

Acceptance level	Minimum laminar imperfection size (B_{min}) [1] mm²	Circumferential dimension (C) mm
B1	165	12
B2	$165 + \frac{\pi D}{4}$ [2]	6 to 12
B3	$165 + \frac{\pi D}{2}$ [2]	9 to 15
B4	$165 + \pi D$ [2]	12 to 20

1) B_{min} = product of longitudinal and circumferential dimensions. This product shall be rounded up to the nearest 10 mm².

2) D = outside diameter of tube, in millimetres.

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 untested length using the appropriate acceptance limits.

4.3 The maximum width of each individual transducer, measured parallel to the major axis of the tube, shall be 30 mm. The minimum ultrasonic transducer 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 calibration of non-destructive testing of equipment. The dimensions of these standards should not be construed as the minimum sizes 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 reference standards comprising flat bottomed round, square or rectangular recesses (see figure 1) machined into the inner surface of a tubular test piece (see 7.1.2), with the exception that for acceptance level B1, only the flat bottomed round recess shall be used.

The reference standard with a flat bottomed round recess shall be used as the primary means of establishing the test sensitivity. When using one of the other types of reference standards, the test sensitivity shall be adjusted 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.).

6 Dimensions of reference standards

6.1 The dimensions of the reference standard, when used, shall be as follows:

6.1.1 Width (circumferential dimension)

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

6.1.2 Recess depth

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

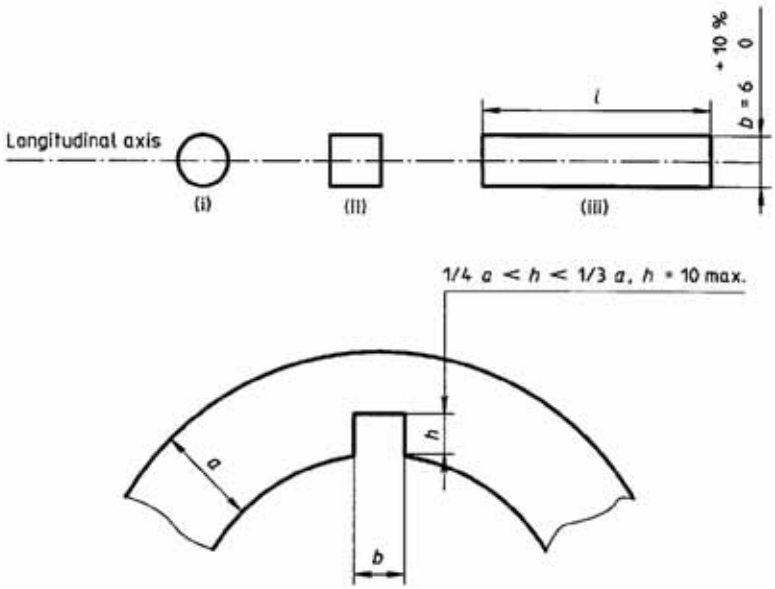
6.2 The reference standard dimensions and shape shall be verified by a suitable technique.

7 Equipment calibration and checking

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

By agreement between the purchaser and manufacturer, the equipment may also be checked dynamically to prove that, at the inspection pitch and pulse repetition frequency selected, the equipment will detect the relevant minimum lamination size (B_{min}) given in table 1.

Dimensions in millimetres



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

b = width of rectangular recess

h = depth of rectangular recess

a = wall thickness of tube

Figure 1 — Reference recess forms

7.1.1 Calibration using an electronic technique

With the transducer assembly positioned on the tubular test piece, the full amplitude of the first back wall echo minus 10 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 sensitivity, the equipment will detect, under static conditions, the reference recess as given in 5.2. If not, the necessary adjustment in sensitivity shall be made prior to the testing of production tubes.

7.1.2 Calibration using a 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 rotational and/or translational speeds, together with the equipment pulse repetition frequency, shall be chosen in order to detect the relevant minimum lamination size (B_{min}) with a circumferential dimension (C), 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, wall thickness and grade.

The frequency of checking the 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 changeover 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.

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 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 designed 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 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 laminated suspect area. The tube shall be deemed to have passed this test if the lamination size (B_{max}) and the total summed area of laminations greater than B_{min} and less than B_{max} given in table 2, are not exceeded.

b) 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.

c) 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 inspection technique;

g) description of the reference standard;

h) equipment calibration method used.

Table 2 — Acceptance limits

Acceptance level	Minimum individual lamination size to be considered (B_{min}) mm²	Maximum allowable individual lamination size (B_{max}) mm²	Total summed area of laminations $> B_{min}$ and $< B_{max}$	
			Locally per metre of tube (% of $\pi D \times 1\,000$) mm²	Average per metre of total tube length (% of $\pi D \times 1\,000$) mm²
B1	—	165	—	—
B2	$165 + \frac{\pi D}{4}$	$165 + \pi D$	1 %	0,5 %
B3	$165 + \frac{\pi D}{2}$	$165 + 2\pi D$	2 %	1 %
B4	$165 + \pi D$	$165 + 4\pi D$	4 %	2 %

NOTES

1 D = outside diameter of tube, in millimetres.

2 $B_{min.}$ and $B_{max.}$ calculated according to this table, shall be rounded up to the nearest 10 mm².

3 For the purposes of 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.

ICS 23.040.10; 77.040.20; 77.140.30

Descriptors: pipes (tubes), metal tubes, steel tubes, seamless tubes, welded tubes, pressure pipes, tests, non-destructive tests, ultrasonic tests, determination, defects.

Price based on 5 pages