
**Titanium pipes and tubes —
Non-destructive testing —
Part 2:
Ultrasonic testing for the detection of
longitudinal imperfections**

Canalisations et tubes en titane — Essai non destructif —

*Partie 2: Contrôle par ultrason pour la détection des défauts
longitudinaux*



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Published in Switzerland

Foreword

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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 25902-2 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 11, *Titanium*.

ISO 25902 consists of the following parts, under the general title *Titanium pipes and tubes — Non-destructive testing*:

- *Part 1: Eddy-current examination*
- *Part 2: Ultrasonic testing for the detection of longitudinal imperfections*

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Titanium pipes and tubes — Non-destructive testing —

Part 2:

Ultrasonic testing for the detection of longitudinal imperfections

1 Scope

This part of ISO 25902 specifies an ultrasonic testing method for detecting longitudinal imperfections in titanium seamless tubes or welded tubes.

This part of ISO 25902 also applies to titanium alloy tubes.

In this part of ISO 25902

- a) the minimum wall thickness is 0,3 mm,
- b) only rectangular notches are permitted as reference reflectors, and
- c) the minimum notch depth is 0,08 mm.

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 10375, *Non-destructive testing — Ultrasonic inspection — Characterization of search unit and sound field*

ISO 18175, *Non-destructive testing — Evaluating performance characteristics of ultrasonic pulse-echo testing systems without the use of electronic measurement instruments*

3 General

3.1 Applicable dimension range

The range of the applicable dimensions of a tube shall be 10 mm to 150 mm outside diameter and 0,3 mm to 10 mm thickness. The ratio of thickness to outside diameter shall be less than or equal to 0,2 (20 %).

3.2 Testing technique

The test shall be carried out using an ultrasonic angle beam technique, effected by rotating the ultrasonic transducer or the tube.

The ultrasonic testing system shall be an immersion technique (including a local immersion technique).

3.3 Personnel

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

Non-destructive testing (NDT) operators shall be authorized by a level 3 NDT individual approved by the employer.

4 Apparatus

4.1 Ultrasonic system, composed of an ultrasonic instrument, at least one ultrasonic transducer, a tube-feeding device, a rotary device for transducers or tubes, and an automatic alarm and recording system.

The performance of the transducer shall comply with ISO 10375.

The whole test system, i.e. instrument, transducer, tube-feeding device, automatic alarm and recording system, shall be capable of detecting the required reference reflector with a sufficient signal-to-noise ratio.

4.2 Ultrasonic instrument, whose amplitude linearity shall be measured in accordance with ISO 18175. The sum of the absolute values of the positive and negative maximum deviation shall be less than or equal to 8 %.

4.3 Ultrasonic transducer.

4.3.1 The nominal transducer diameter shall be between 5 mm and 20 mm (including a rectangular shape having almost the same area as it) and, if necessary, a focusing transducer shall be used.

4.3.2 The nominal frequency shall be 4 MHz to 10 MHz.

5 Reference tube

5.1 Purpose

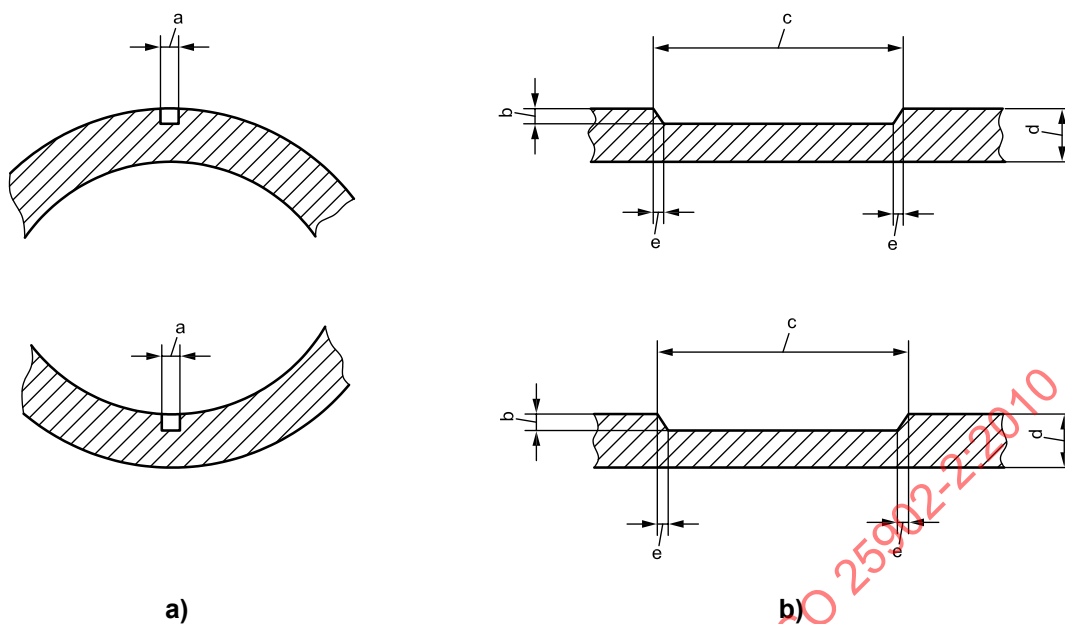
The reference tube shall be used for setting the test sensitivity and for periodical performance tests to demonstrate that the required test sensitivity is maintained.

5.2 Materials

Materials to be used for a reference tube shall have the same material grade, nominal diameter, thickness, surface finish and heat-treatment condition as those of the tubes to be tested, and shall have similar acoustic properties (e.g. velocity, attenuation coefficient).

5.3 Reference reflectors

5.3.1 Classification and shapes of reference reflectors. The reference reflectors shall be rectangular notches, as shown in Figure 1.

**Key**

- a Width of notch.
- b Depth.
- c Length of notch.
- d Thickness.
- e At most 10 % of length.

Figure 1 — Shape of reference reflectors for sensitivity setting

5.3.2 Dimensions of reference reflectors and their tolerances shall be as given in Table 1.

Table 1 — Dimensions of reference reflectors and their tolerances

Dimensions in millimetres

Type of notch	Depth	Tolerance on depth	Length <i>l</i>	Width
N-0,08	0,08	±0,05	10 ≤ <i>l</i> ≤ 25	1,0 max.
N-0,10	0,10			
N-0,20	0,20			
N-0,40	0,40	±15 % (±0,05 min.)		
N-12,5	12,5 % of thickness			
N-15	15,0 % of thickness			
N-20	20,0 % of thickness			
N-25	25,0 % of thickness			

5.4 Fabrication of reference notches.

The reference notches shall be fabricated as follows:

- for seamless tubes: by electric-discharge or mechanical machining;
- for welded tubes: by electric-discharge or mechanical machining in the parent material of the tube;
- axially on the inner and outer surface of the tube. However, for tubes with an inside diameter of less than 15 mm, only notches on the outer surface are required.

5.5 Distance of reference reflectors.

In order to obtain clearly distinguishable signal indications, the notches shall be sufficiently separated from the ends of the reference tubes and from each other.

5.6 Verification of reference reflectors.

The dimensions and shape of reference reflectors shall be verified by a suitable technique.

6 Test method

6.1 Ultrasonic test system

During testing, the tubes and/or the transducer assembly shall be moved relative to each other so that the complete tube surface is scanned. During scanning, the tubes shall be tested in two opposing circumferential directions of sound propagation, unless otherwise agreed between the purchaser and manufacturer.

6.2 Setting

6.2.1 Period for setting test sensitivity

The test sensitivity shall be set before the start of the test.

6.2.2 Reference reflectors for setting test sensitivity

The parameters of reference reflectors to be used for setting the test sensitivity according to the class, the usage, the manufacturing method, the finishing method, and the wall thickness of the tube to be tested are listed in Table 2.

Table 2 — Reference reflectors for setting test sensitivity

Class	Use	Manufacturing method	Finishing method	Thickness, δ mm	Type of rectangular notch
UA	For heat exchanger	Welded tube	As-welded or cold drawing	$0,3 \leq \delta < 0,5$	N-0,08
UB				$0,5 \leq \delta < 0,8$	N-0,10
				$0,8 \leq \delta < 3$	N-12,5
		Seamless tube	Cold drawing	$1 \leq \delta < 1,6$	N-0,20
$1,6 \leq \delta \leq 5$				N-12,5	
UC	For piping	Welded tube	As-welded or cold drawing	$1 \leq \delta \leq 10$	N-15
UD		Seamless tube	Cold drawing	$1 \leq \delta \leq 10$	N-20
UE			Hot extrusion	$3 \leq \delta \leq 10$	N-25
			Cold rolling	$1 \leq \delta < 1,6$	N-0,40
				$1,6 \leq \delta \leq 10$	N-25

6.2.3 Test procedure

6.2.3.1 The sensitivity of the ultrasonic instrument shall be set with the reference reflectors selected from Table 2.

6.2.3.2 The sensitivity of the ultrasonic instrument shall be set so that the indication from the reference reflectors becomes from 50 % to 80 % of the screen height.

6.2.3.3 The automatic alarm system or the recorder shall be adjusted to operate within a normal operation range under the same condition as actual testing.

7 Acceptance criteria

Accept only those tubes where no signal with an amplitude higher than that from the reference reflectors in the reference tube has been detected. Reject all other tubes.

8 Periodical confirmation of correct setting

It shall be confirmed at least every 4 h that the sensitivity of the ultrasonic instrument is suitably maintained when the testing is continuously performed, and when the testing operation ends or is interrupted.

Where an unacceptable deviation of the test sensitivity is discovered during testing, perform readjustment and re-examine all the tubes tested in the abnormal period.

9 Verification of test system

The performance of the complete test system shall be verified periodically. The system shall show the required performance in detecting and evaluating the relevant test reflectors.

10 Test report

The test report shall contain at least the following information:

- a) date of test;
- b) names of testing personnel;
- c) a reference to this part of ISO 25902 and details of any special agreements;
- d) symbol for the tube and material grade;
- e) dimensions of tube;
- f) complete list of equipment;
- g) reference tube and reference reflectors;
- h) identification of ultrasonic transducers;
- i) testing technique and conditions (linear and rotational testing speed, parameters of sensitivity calibration, etc.);
- j) test results.