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## Steel — Ultrasonic testing for steel flat products of thickness equal to or greater than 6 mm

*Aciers — Contrôle ultrasonore des produits plats en acier d'épaisseur  
supérieure ou égale à 6 mm*

**ITEH STANDARD PREVIEW**  
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Full standard:  
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword + Supplementary information](#)

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis)*.

This second edition cancels and replaces the first edition (ISO 17577:2006), which has been technically revised.

# Steel — Ultrasonic testing for steel flat products of thickness equal to or greater than 6 mm

## 1 Scope

This International Standard specifies a method for the automated and/or manual ultrasonic testing of uncoated steel flat products for internal discontinuities by the pulse echo technique. It is applicable to non-alloyed or alloyed steel flat products, in a nominal thickness range of 6 mm to 200 mm. However, this International Standard may be applied to austenitic and austenitic-ferritic steels, provided that the difference between the amplitude of the noise signal and that of the echo detection threshold is sufficient for the limit fixed. Unless otherwise agreed, for testing of steel flat products for welded steel tubes, ISO 10893-9 applies.

Other techniques of testing (e.g. by transmission) or other test equipment may be used at the manufacturer's discretion, provided that they give identical results to those obtained under the conditions of this International Standard. In the event of a dispute, only the method defined in this International Standard will prevail.

Testing of flat products, of thickness less than 6 mm and over 200 mm, may be the subject of special agreements between the parties concerned.

Testing is normally carried out in the place of production or on the premises of the supplier.

## 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 NDT personnel*

ISO 10893-9, *Non-destructive testing of steel tubes — Part 9: Automated ultrasonic testing for the detection of laminar imperfections in strip/plate used for the manufacture of welded steel tubes*

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 following terms and definitions apply.

### 3.1

#### **internal discontinuity**

any imperfection lying within the thickness of the flat products, e.g. planar or laminar imperfection, single-plane or multi-plane inclusion bands or clusters

### 3.2

#### **defect**

unacceptable internal discontinuities, i.e. exceeding the specified maximum size or population density limits

### 3.3

#### **population density**

number of individual internal discontinuities of a size greater than a specified minimum size and less than a specified maximum size per specified area of body or length of edge zone

### 3.4

#### **manual and assisted manual testing**

testing by an operator applying an ultrasonic probe to the flat-product surface, manually executing the appropriate scanning pattern on the flat-product surface and visually assessing ultrasonic signal indications on the electronic equipment screen either by direct viewing or by built-in signal amplitude alarm devices

### 3.5

#### **automated and semi-automated testing**

testing using a mechanized means of applying the ultrasonic probe or probes to the flat-product surface and executing the appropriate scanning pattern, together with ultrasonic signal evaluation by electronic means

Note 1 to entry: Such testing can be either fully automated with no operator involvement or semi-automated when the operator performs basic equipment operation functions.

### 3.6

#### **dead zone**

zone adjacent to the scanning surface within which reflectors of interest are not revealed

## 4 Principle

The method used is based on the reflection of ultrasonic waves (generally longitudinal waves), the mean direction of which is perpendicular to the main surface of the flat products.

The examination consists of the following:

- a) locating any discontinuity by comparing the amplitude of the discontinuity echo with the amplitude of the echo of a flat-bottomed hole of a given diameter and located at the same depth as the discontinuity (DGS-method);

NOTE Only those discontinuities giving an echo height exceeding in amplitude that of the echo obtained with the reference flat-bottomed hole are taken into consideration.

- b) Then determining its area, the contour of the discontinuity being defined by the positions of the centre of the probe corresponding to an echo amplitude of half the maximum amplitude of the discontinuity under consideration (6 dB drop technique).

The examination shall be carried out from one side only.

In the case of automated testing, the location of a discontinuity and the determination of its area can be realized using different algorithms together with high scanning density. In case of dispute, the 6 dB drop technique in [8.1.1](#) should be used.

## 5 Personnel

Automated testing shall be carried out only by qualified personnel under the responsibility of Level 2 or Level 3 qualified person. Qualification shall include regular training, success in examination, experience and satisfactory vision test according to the standards mentioned below. Manual testing shall be carried out only by personnel qualified at minimum Level 1 and under the responsibility of Level 2 or Level 3 qualified person.

Qualification of the responsible person shall be in accordance with ISO 9712, ISO 11484 or an appropriate national/ regional standard.

NOTE Examples of appropriate standards are listed in the Bibliography.

## 6 Testing system

### 6.1 General requirements

The pulse echo technique with normal incidence to the scanning surface shall be used for the ultrasonic testing.

The instrument shall be equipped with time-base regulation and the gain control shall be calibrated in decibels. The electronic equipment shall be appropriate for the ultrasonic probes and frequencies used.

The transmitted pulse repetition frequency shall be appropriate for the applied scanning speed.

The instrument shall detect the ultrasonic signals of internal discontinuities by using a gate function. The output signal shall be provided for devices like display monitor or recording equipment.

The coupling medium shall ensure an adequate contact between the probe and the surface of the flat products and maintain sufficient coupling during scanning.

### 6.2 Manual testing instrument

The instrument shall be equipped with an A-scan display monitor that allows the assessment of the path of ultrasonic waves in the flat products. The A-scan shall be clearly visible, the peaks corresponding to the successive echoes being sharp and very clear.

### 6.3 Automated testing system

The automated testing system shall be equipped with the following:

- a) a suitable mechanical means for scanning the surface of flat products with a defined density;
- b) probe holders that are capable of following the surface contour of a flat product to be tested, in order to maintain normal incidence;
- c) appropriate electronics including, for example, transmitters, receivers, multiplexer, gates, display monitor, as well as a means for data collection;
- d) appropriate means for signal evaluation, recording (e.g. mapping) and storing;
- e) means for setting of equipment (i.e. test sensitivity, range and gate position), for example, by the use of reference blocks, input of artificial signals, downloading distance-amplitude curves (DAC) or downloading stored calibration files;
- f) means for control of pulse repetition frequency related to the scanning speed;
- g) means for coupling and function check (e.g. by surveillance of back-wall echo);
- h) function to indicate the location of discontinuities with reference to an edge of the flat product (printer, recorder or display).

### 6.4 Performance of electronic equipment

#### 6.4.1 Linearity

- a) Linear amplifiers: the deviation of the vertical linearity shall not exceed  $\pm 1$  dB in any part of a 20 dB span.
- b) Logarithmic amplifiers: the deviation of the vertical linearity shall not exceed  $\pm 1$  dB in any part of a 20 dB span and  $\pm 2$  dB in any part of a 60 dB span.
- c) Horizontal linearity: the deviation of the horizontal linearity shall not exceed  $\pm 2$  % of the testing range.

The vertical linearity shall be checked at least once a year, unless the conditions dictate a higher frequency of checking. The results of all checks shall be recorded.

**6.4.2 Dead zone**

The dead zone results from combination of probe characteristics with the actual setting of the instrument used.

The dead zone of single-element probes connected to the instrument used shall be as small as possible, i.e. max. 15 % of the thickness of the flat products or 15 mm, whichever is the smaller. For product thicknesses less than 10 mm, the dead zone shall be less than or equal to 1,5 mm.

**6.5 Probes**

The probes shall be single-element probes, dual-element probes or multiple dual-element probes, depending on the thickness of the flat products as given in [Table 1](#).

**Table 1 — Probe types**

Specified thickness of the flat products or path length mm	Probe type <sup>a, b</sup>
$6 \leq e \leq 60$	Dual-element probe
$60 < e \leq 200$	Single or dual-element probe
<sup>a</sup> In the event of dispute, the type of probe to be used shall be the subject of an agreement between the parties involved. <sup>b</sup> As long as the stipulation of the dead zone is satisfied, it is permissible to use single-element probes or flat products of less than or equal to 60 mm thickness.	

The probes shall have a nominal frequency in the range of 2 MHz to 5 MHz. Probes with a frequency outside the range of 2 MHz to 5 MHz can be used for material with special acoustic characteristics, if agreed at time of enquiry and order.

The focal zone of dual-element probes shall be adapted to the thickness of the flat products.

The relevant dimension of transducers shall be less than or equal to 30 mm in diameter or in rectangularity.

**6.6 Coupling medium**

The coupling medium shall ensure an adequate coupling between the probe and the surface of the flat products. Water is normally used, but other coupling media (e.g. oil, paste) may be used at the discretion of the supplier. The coupling medium should be chosen to avoid inter-crystalline corrosion, e.g. when applied to austenitic steel, and in such cases should be adequately removed after testing by an appropriate method.

**7 Test procedure**

**7.1 Time of testing**

Unless otherwise agreed at the time of enquiry and order, the time for ultrasonic testing shall be left at the discretion of manufacturer.



## 7.2 Scanning plan

### 7.2.1 General

For the flat-product body, the testing is based on statistical methods unless otherwise specified in the order.

Scanning of the flat products shall be carried out in accordance with 7.2.2 and/or 7.2.3 and corresponding to the required quality class.

By agreement at the time of ordering, a scanning with defined scan coverage or a scanning of all body parts of the flat products may be provided, the operating conditions being included in the agreement.

### 7.2.2 Testing of the flat-product body

For the flat-product body, the scanning comprises continuous testing along the lines of a grid parallel to the edges of the flat products, or along the parallel or oscillating lines distributed uniformly over the area, given the same degree of coverage:

- a) for Classes B<sub>1</sub> and B<sub>2</sub> the scanning pattern shall be the grid lines of a 200 mm square, or vertical or horizontal lines at 100 mm pitch;
- b) for Classes B<sub>3</sub> and B<sub>4</sub> the scanning pattern shall be the grid lines of a 100 mm square, or vertical or horizontal lines at 50 mm pitch.

### 7.2.3 Testing of the edges of the flat products

Scanning of the edges comprises a full testing of a zone in accordance with Table 2 over the four edges of the flat products.

Table 2 — Zone width for flat-product edges

Thickness of the flat products mm	Zone width mm
$6 \leq e \leq 60$	50
$60 < e \leq 100$	75
$100 < e \leq 200$	100

## 7.3 Scanning condition

7.3.1 In the case of scanning with a dual-element probe, the direction of the acoustical barrier shall be oriented perpendicular or 45° to the scanning direction.

7.3.2 The scanning speed shall not impede the testing.

- a) In the case of automated testing, the scanning speed and the pulse repetition frequency shall be set to ensure full coverage of the scan lines by ultrasonic pulses.
- b) The scanning speed of manual testing without an automated alarm system shall be less than or equal to 500 mm/s.

NOTE The maximum scanning speed depends on different factors such as product thickness, sensitivity or coupling conditions.