INTERNATIONAL STANDARD

**ISO 17405**

Second edition
2022-04

# Non-destructive testing — Ultrasonic testing — Technique of testing claddings produced by welding, rolling and explosion

*Essais non destructifs — Contrôle par ultrasons — Technique d'essai des placages produits par soudage, laminage et explosion*



Reference number
ISO 17405:2022(E)

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Published in Switzerland

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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).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).



This second edition cancels and replaces the first edition (ISO 17405:2014), which has been technically revised. The main changes are as follows:

— the normative references have been updated;

— the terms have been aligned with ISO 5577;

— the term 3.2 test surface and its definition have been deleted;

— Clause 4 on Personnel qualification has been added;

— the requirements in 5.2.4 for the adaption of probes to curved surfaces have been modified;

— editorial corrections have been made.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

# Non-destructive testing — Ultrasonic testing — Technique of testing claddings produced by welding, rolling and explosion

## 1 Scope

This document specifies the techniques for manual ultrasonic testing of claddings on steel applied by welding, rolling and explosion using single-transducer or dual-transducer probes.

The test is intended to cover detection of two-dimensional or three-dimensional discontinuities in the cladding and in the region of the interface.

This document does not give acceptance criteria nor define the extent of testing.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 testing — Vocabulary*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 22232-1, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 1: Instruments*



ISO 22232-2, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 2: Probes*

ISO 22232-3, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 3: Combined equipment*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1**
**test object**
part to be tested

## 4 Personnel qualification

Personnel performing testing in accordance with this document shall be qualified to an appropriate level in accordance with ISO 9712 or equivalent in the relevant industrial sector.

# 5 Ultrasonic test system

## 5.1 General

The ultrasonic pulse-echo technique is used.

For two-dimensional discontinuities parallel to the test surface and three-dimensional discontinuities, straight-beam probes (dual-transducer or single-transducer) shall be used for testing with longitudinal waves.

For discontinuities with any other orientation, dual-transducer angle-beam probes for longitudinal waves shall be used.

The nominal frequency shall be selected according to the purpose of the test and the characteristics of the materials.

Frequencies from 2 MHz to 6 MHz should be preferred.

The instrument used shall conform to the requirements given in ISO 22232-1, and the probes shall conform to the requirements of ISO 22232-2.

The whole test system shall be checked by the operator periodically as given in ISO 22232-3.

## 5.2 Requirements regarding probes



### 5.2.1 Single-transducer straight-beam probes for longitudinal waves

A depth zone providing optimum sensitivity is defined (see Annex A) by the size of the transducer used in the probe. The position of this zone shall be selected according to the expected position of the discontinuities.



### 5.2.2 Dual-transducer straight-beam probes for longitudinal waves

A depth zone providing optimum sensitivity is defined (see Annex A) by the size of the transducers used in the probe and their roof angle. The position of this zone shall be selected according to the expected position of the discontinuities.

### 5.2.3 Dual-transducer angle-beam probes for longitudinal waves

The beam angle should be between 65° and 80° in the cladding.

The skew angle, and the shape and size of the transducers, shall be selected so that the depth range for optimum sensitivity (see Annex A) covers the expected position of the discontinuities.

### 5.2.4 Adaption of probes to curved scanning surfaces

The gap, $g$, between test surface and bottom of the probe shall not be greater than 0,5 mm.

For flat probes on cylindrical or spherical surfaces, this requirement can be checked with Formula (1):

$$g = \frac{a^2}{4D} \tag{1}$$

where

$a$ is the dimension of the probe in the direction of curvature, in mm;

$D$ is the diameter of the test object, in mm.

If a value for $g$ larger than 0,5 mm results from Formula (1), the probe shall be adapted to the surface, and the sensitivity and range shall be set accordingly.

For spherical or complex shaped surfaces, Formula (1) shall be applied in both length and width direction of the probe (possible differences in curvature and/or probe dimensions).

## 5.3 Additional requirements

### 5.3.1 Test ranges

The ultrasonic instrument shall facilitate an expanded time base ("zoom mode").

### 5.3.2 Echo width

The echo width visible on the screen shall be taken into account when assessing the suitability for coverage of the selected depth zone.

This applies to all types of probes: single-transducer straight-beam probes, dual-transducer straight-beam probes, and dual-transducer angle-beam probes.

## 5.4 Instrument settings

### 5.4.1 Range setting



Range setting of the ultrasonic instrument for accurate localization of discontinuities when using dual-transducer probes should be carried out using reference blocks as shown in Figure 1 or Figure 2 for example, made of materials similar to the test object, or it may be carried out on the test object itself.

A dual-transducer straight-beam probe can, for example, be placed on the various steps of a step wedge calibration block.



When dual-transducer angle-beam probes are used on a reference block as shown in Figure 2, for example, the reduced projected sound path length shall be lined up with the appropriate marks on the screen.

In this manner, it is possible to read the position of a reflector directly on the screen, i.e. for the setting with reduced projected sound path length as well as with depth positions.

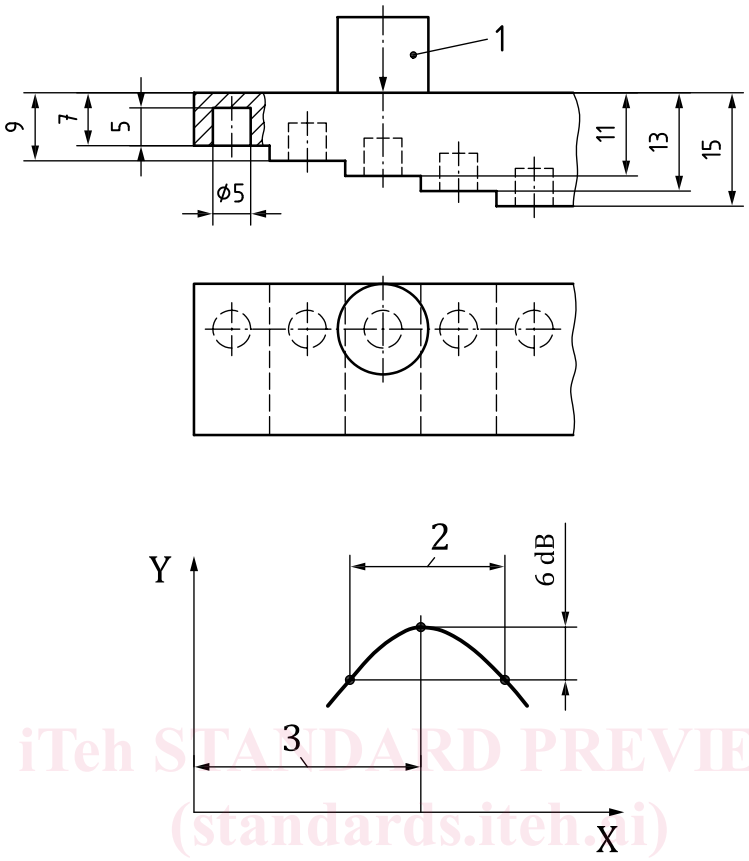
It is recommended to mark the range of any discontinuities to be detected on the screen according to their depth position (normally corresponding to the thickness of the cladding).

When straight-beam probes are used, the range of the ultrasonic instrument should be set using multiple-echo series from a plane-parallel steel plate of known thickness and sound velocity (e.g. calibration block No. 1 according to ISO 2400).

Since transverse waves are also generated when angle-beam probes are used for longitudinal waves, care shall be taken to ensure that no erroneous indications of transverse waves are used during the setting procedure. In any case, these indications have a considerable larger time of flight than those of longitudinal waves.

When reference blocks are used, all dimensions not specified shall be selected so that the measurement or setting is not impaired by echoes from the geometry of the test block.

Dimensions in millimetres





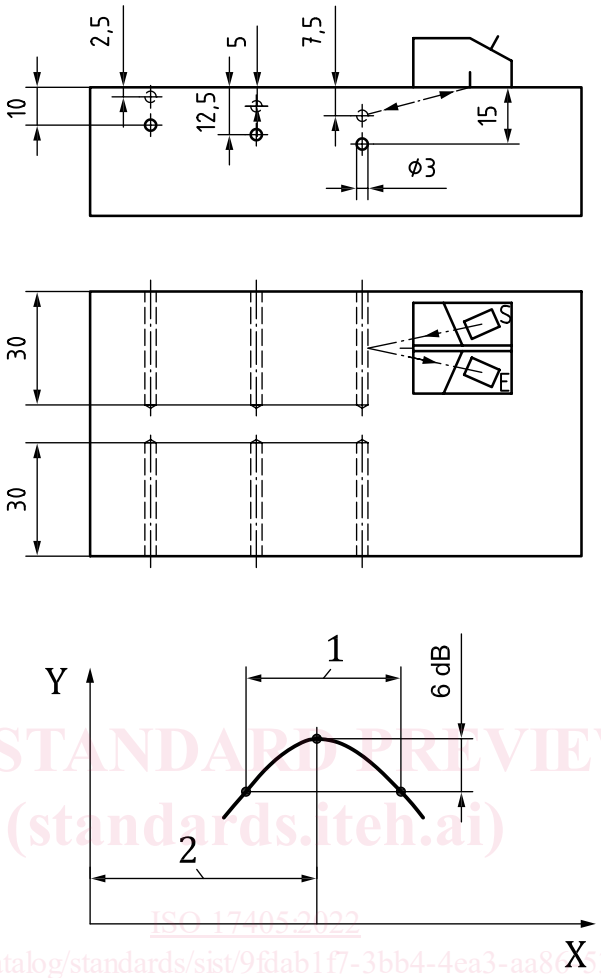

**Key**

X distance along the beam axis
Y echo height
1 probe
2 length of the focal zone
3 focal distance



**Figure 1 — Reference block for dual-transducer straight-beam probes and representation of the focal zone**

Dimensions in millimetres






**Key**

X distance along the beam axis
Y echo height
1 length of the focal zone
2 focal distance

**Figure 2 — Reference block for dual-transducer angle-beam probes and representation of the focal zone**

### 5.4.2 Sensitivity setting

a) For sensitivity setting, it is recommended to choose reference reflectors (type, orientation and size) according to the expected discontinuities.

b) A reference block with a cladding of the same type as the one to be tested shall be used for setting the sensitivity.

c) The thickness of the cladding, the surface preparation, and the shape of the test surface shall be the same as those of the object to be tested (see Clause 6).

d) If the probes have to be adapted to curved test surfaces, the reference blocks used shall also have test surfaces on which the probe fits, as specified in 5.2.4.

e) For the detection of volumetric discontinuities, side-drilled holes of, for example, 3 mm diameter and 30 mm length in the parent metal at the interface with the cladding should be used for sensitivity setting (see Figure 3).

f) For claddings produced by welding, one hole shall be made perpendicular to the direction of welding and one parallel to this direction.

g) For double- or multi-layer welded claddings, it can be necessary to use further holes between the individual layers.

h) For the detection of planar discontinuities parallel to the test surface, flat-bottomed holes should be used for sensitivity setting with straight-beam probes (single-transducer or dual-transducer).

i) For the detection of planar discontinuities perpendicular to the test surface, notches should be used for sensitivity setting with angle-beam probes.

j) In Figure 3, position 1 (dual-transducer straight-beam probe), position 2 (dual-transducer angle-beam probe) and position 3 (straight-beam probe) show how the reference reflector echo shall be generated for setting the test sensitivity of the instrument.

k) The echo height should be set to 40 % of full screen height.

l) When straight-beam probes are used, only reference blocks of the same or larger wall thickness as the test object shall be used.

m) If these thicknesses are different, the corresponding difference of sensitivity shall be compensated.

n) Note the gain required to set an indication to 40 % of the full screen height for positions 1, 2 and 3.

o) For all probes, the noise level shall be determined by moving the probe across a representative area of the surface of the test object.

p) While this is done, the instrument gain shall be set so that the noise peaks produce indications up to 40 % of the full screen height, when the probe is continuously moved (resulting from the structure of the material and the roughness and undulations of the contact surface) over the area where indications from discontinuities are expected.

q) There shall be at least 6 dB separation between the echo height of the reference reflector and the noise level.

r) If necessary, the test surface should be machined to achieve this, and/or other probes should be used.

s) Dimensions *a*, *b*, *c*, *d*, and *e* in Figure 3 shall be selected so that, in each case, the probe can be coupled to the test object without difficulty and echoes from the geometry of the block do not affect the gain setting.