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Non-destructive testing — Characterization and verification of ultrasonic test equipment —

Part 3: Combined equipment

Essais non destructifs — Caractérisation et vérification de l'appareillage de contrôle par ultrasons —
Partie 3: Equipement complet

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 22232 series can be found on the ISO website.

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.

Non-destructive testing — Characterization and verification of ultrasonic test equipment —

Part 3: Combined equipment

1 Scope

This document specifies methods, tolerances and acceptance criteria for verifying the performance of combined ultrasonic test equipment (i.e. instrument, probes and cables connected) by the use of appropriate standard calibration blocks.

These methods are specifically intended for manual test equipment, i.e. ultrasonic instruments according to ISO 22232-1, and for manual ultrasonic non-destructive testing with single- or dual-transducer probes according to ISO 22232-2. This document is also applicable for multi-channel instruments. For automated test equipment, different tests can be needed to ensure satisfactory performance.

The specified methods are intended for the use by operators working under site or shop floor conditions.

These methods are not intended to prove the suitability of the equipment for particular applications.

This document excludes ultrasonic instruments for continuous waves.

This document also excludes ultrasonic phased array systems, see e. g. ISO 18563-3. If a phased array instrument is used in combination with single- or dual-transducer probes, this document is applicable to this combination.

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 2400, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 1*

ISO 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO 7963, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 2*

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*

3 Terms and definitions

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

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

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

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

4 General requirements for conformity

The combined equipment complies with this document if it fulfils all of the following requirements:

a) the ultrasonic instrument shall comply with ISO 22232-1;

b) the probe shall comply with ISO 22232-2;

c) the combined equipment shall comply with Clause 6;

d) the results of the baseline tests, 6.1, shall be reported including the instruments settings of the relevant parameters used for the baseline measurements.

The tests specified in this document, together with the frequency of testing, are summarized in Table 1.

Table 1 — Tests to be performed

Title of test	Frequency of testing	Subclause
Physical state and external aspects	Daily	6.2
Probe index point	Daily	6.3.2/6.3.4
Beam angle	Daily	6.3.3/6.3.4
Vertical linearity	Weekly[a]	6.4
Sensitivity and signal-to-noise ratio	Weekly[a]	6.5
Pulse duration	Weekly[a]	6.6
[a] It may be more convenient for the user to perform the weekly tests each time the equipment is used.		

Non-compliance with the requirements in this document shall result in replacement, repair and/or verification according to ISO 22232-1 Group 2 tests or to ISO 22232-2 for the affected component.

5 Personnel qualification

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

6 Description of tests and reporting

6.1 Baseline measurements of characteristic values

For each set of combined equipment (instrument, cables and probe), base values shall be determined and reported. The later measured values are to be compared against the base values.

For angle-beam probes, initially the user shall establish base values for the probe index point (6.3.2.2/6.3.4.2) and the beam angle (6.3.3.2/6.3.4.2), unless these values are available for new probes.

For all systems, initially the user shall establish base values for the sensitivity, the signal-to-noise ratio and the pulse duration using the methods given in 6.5.2 and 6.6.2. These shall either be measured for the actual probe and instrument to be used for subsequent testing or for each combination of probe type and instrument type to be used.

During the baseline measurements, the relevant parameters of the instrument controls, e.g. frequency, pulse energy, suppression/reject, pulse repetition frequency, shall be the same as those to be used for subsequent tests.

The type of test block, cable type and cable length used for these baseline measurements shall also be the same as those used for subsequent tests.

For the measurement of base values, it is assumed that the probe(s), cable(s) and instrument are in proper condition, especially for used parts.

6.2 Physical state and external aspects

6.2.1 Procedure

Visually inspect the outside of the ultrasonic instrument, probe(s), cable(s) and calibration block for physical damage or wear which can influence the system's current operation or future reliability.

In particular, inspect the probe contact surface for physical damage or wear.

If the probe is assembled from separate components, test that the components are assembled correctly, e. g. provide suitable coupling.

Test for instability of electrical contacts.

6.2.2 Acceptance criterion

Any damage or wear which can influence the system's current operation or future reliability, e. g. by instability of electrical contacts, shall result in replacement, repair and/or verification according to Group 2 tests of ISO 22232-1 or to ISO 22232-2 for the affected component.

6.2.3 Frequency of testing

The equipment shall be tested once per day for the equipment to be used during that day.

6.3 Tests for angle-beam probes

6.3.1 General

The probe index point and the beam angle shall be determined either:

— separately as specified in 6.3.2 and 6.3.3; or

— simultaneously as specified in 6.3.4.

These tests shall be performed for each angle-beam probe to be used during that day.

The geometry, surface conditions and material of the reference block shall be documented.

6.3.2 Probe index point

6.3.2.1 General

The probe index point shall be verified on calibration blocks according to ISO 2400 or ISO 7963. The probe index point shall be verified prior to the determination of the beam angle.

6.3.2.2 Procedure

Position the probe on the appropriate side of the block to obtain a reflection from the quadrant.

Move the probe backwards and forwards to maximize the amplitude of the reflected signal, taking care to move the probe parallel to the block sides.

When the amplitude is at its maximum, the true probe index point corresponds to the engraved line on the block which marks the geometrical centre of the quadrant.

6.3.2.3 Acceptance criterion

The measured probe index point should be within ±1 mm of the nominal position. For new probes, the specified nominal value shall be used as the base value.

If the measured position differs from the existing mark or from the provided probe index value by more than 1 mm, the new position shall be documented and preferably marked on the probe sides and used in subsequent probe tests and plotting of discontinuities.

6.3.2.4 Frequency of testing

The frequency of testing depends on the rate of probe wear due to usage and the roughness of the test surface. When a probe is in continuous use, the test shall be carried out at least every few hours; otherwise, a daily test shall be performed for probes to be used during that day.

6.3.3 Beam angle

6.3.3.1 General

The calibration blocks specified in ISO 2400 or ISO 7963 provide a means for rapidly verifying the beam angle. If a higher accuracy is needed, the angle shall be determined using one of the methods specified in ISO 22232-2.

The beam angle shall be determined after verification of the probe index point.

6.3.3.2 Procedure

Place the probe on the calibration block and generate a signal from the selected side-drilled hole. Move the probe backwards and forwards to maximize the signal from the side-drilled hole.

When the signal is at its maximum amplitude, the beam angle can be read from the engraved scale on the calibration block at a point directly below the measured probe index point.

The measured angle shall be documented.

6.3.3.3 Acceptance criterion

The measured beam angle shall be within ±2° of the nominal beam angle. For new probes, the specified nominal value shall be used as the base value.

6.3.3.4 Frequency of testing

The frequency of testing depends on the rate of probe wear due to usage and the roughness of the test surface. When a probe is in continuous use, the test shall be carried out at least every few hours; otherwise, a daily test shall be performed for probes to be used during that day.

6.3.4 Simultaneous determination of probe index point and beam angle

6.3.4.1 General

This method requires the use of a reference block containing at least 3 side-drilled holes at different depth positions.

6.3.4.2 Procedure

Maximize the direct echo amplitude from each side-drilled hole d_i in turn and measure the reduced projection distance a_i between the orthogonal projection of the axis of the side-drilled hole d_i on the test surface and the front of the probe (e. g. with a ruler) in each case.

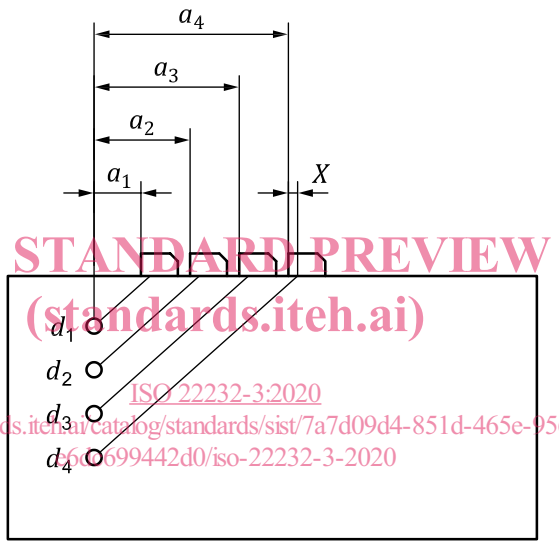
Plot these distances against the depth positions of the side-drilled holes d_i on a scale drawing and draw a straight line through the points.

Both the probe index and the beam angle now can be determined simultaneously (see Figure 1).

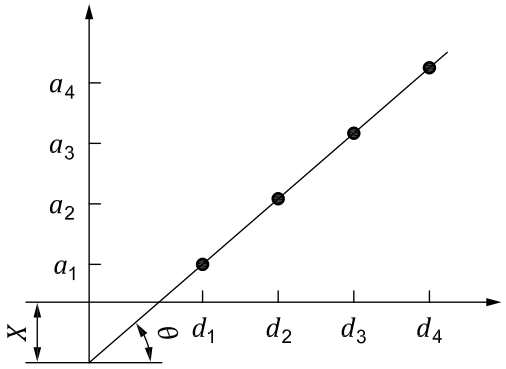
The position of the probe index point corresponds to the distance X in Figure 1.

Calculate the beam angle θ by using Formula (1):

$$\theta = arctan\left(\frac{a_i - a_1}{d_i - d_1}\right) \tag{1}$$



a) Test setup



b) Plot of measurement results

Key

Θ slope = beam angle
a_i reduced projection distance
d_i depth position of the side-drilled hole
X distance between probe front and probe index point

Figure 1 — Simultaneous determination of the probe index point and the beam angle