International Standard

ISO 16823

Non-destructive testing — Ultrasonic testing — Through-transmission technique

Essais non destructifs — Contrôle par ultrasons — Technique par transmission

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 document 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 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).

This second edition cancels and replaces the first edition (ISO 16823:2012), which has been technically revised.

The main changes are as follows:

— normative references have been updated;

— figures have been improved;

— terminology has been aligned throughout the whole document.

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.

Introduction

The following documents are linked:

ISO 16810, *Non-destructive testing — Ultrasonic testing — General principles*

ISO 16811, *Non-destructive testing — Ultrasonic testing — Sensitivity and range setting*

ISO 16823, *Non-destructive testing — Ultrasonic testing — Through transmission technique*

ISO 16826, *Non-destructive testing — Ultrasonic testing — Testing for discontinuities perpendicular to the surface*

ISO 16827, *Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities*

ISO 16828, *Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique as a method for detection and sizing of discontinuities*

Non-destructive testing — Ultrasonic testing — Through-transmission technique

1 Scope

This document specifies the principles of ultrasonic through-transmission techniques.

Through-transmission techniques can be used for:

— detection of discontinuities;

— determination of sound attenuation.

The general principles required for the use of ultrasonic testing of industrial products are described in ISO 16810.

The through-transmission technique is used for the testing of flat products, e.g. plates and sheets.

Further, it can be used for tests, for example:

— where the shape, dimensions or orientation of possible discontinuities are unfavourable for direct reflection;

— of materials with high sound attenuation;

— on thin test objects.

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*[1)]

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

ISO 7963, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. 2*[1)]

ISO 16810, *Non-destructive testing — Ultrasonic testing — General principles*

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

1) It is intended to replace the term "calibration block" by "standard block" during the next revision of the standard.

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/

4 NDT personnel

For requirements concerning non-destructive testing (NDT) personnel, the requirements given in ISO 16810 shall apply.

5 Test equipment

5.1 Instrument

The ultrasonic instrument shall fulfil the requirements of ISO 22232-1.

5.2 Probes

5.2.1 General

The probe(s) shall initially fulfil the requirements of ISO 22232-2.

5.2.2 Probe selection

The choice of the probe depends on the purpose of the testing and the requirements of the referencing standard or specification. It depends on:

— the material thickness, shape and surface condition of the test object;

— the type and metallurgical condition of the material to be tested;

— the type, position and orientation of discontinuities to be detected and assessed.

The probe parameters listed in 5.2.3 and 5.2.4 shall be considered in relation to the characteristics of the test object stated above.

5.2.3 Frequency and dimensions of transducer

The frequency and dimensions of a transducer determine the shape of the sound beam (near field and beam divergence).

a) The selection shall assure that the characteristics of the beam are the optimum for the testing by a compromise between the following:

   1) the near-field length which shall remain, whenever possible, smaller than the thickness of the test object.

      NOTE It is possible to detect discontinuities in the near field, but their characterization is less accurate and less reproducible than in the far field.

   2) the beam width, which shall be sufficiently small within the test volume furthest from the probe to maintain an adequate detection level;

   3) the beam divergence, which shall be sufficiently large for single-probe setups to detect planar discontinuities that are unfavourably orientated.

b) Apart from the above considerations, the selection of frequency shall take into account the influences of the sound attenuation in the material and the reflectivity of discontinuities.

The higher the frequency, the greater the axial resolution, but the sound waves are more attenuated (or the spurious signals due to the structure are greater) than with lower frequencies.

The choice of frequency thus also represents a compromise between these two factors.

Most ultrasonic tests are performed at frequencies between 1 MHz and 10 MHz.

5.2.4 Dead zone

The choice of the probe shall take into account the influence of the dead zone in relation to the test volume.

5.2.5 Damping

The probe selection shall also include consideration of the damping which influences the axial resolution as well as the frequency spectrum.

5.2.6 Focusing probes

Focusing probes are mainly used for the detection of small discontinuities and for sizing reflectors.

Their advantages in relation to non-focused single-transducer probes are an increased lateral resolution and a higher signal-to-noise ratio than with non-focusing probes.

a) Their sound beams shall be described by the focal zones (focal distance, length of the focal zone and width of the focal zone).

b) The sensitivity setting shall be carried out by using reference reflectors.

5.3 Coupling media

a) Different coupling media can be used, but their type shall be compatible with the materials to be tested. Examples are:

   — water, possibly containing an agent, e.g. wetting, anti-freeze, corrosion inhibitor;

   — contact paste;

   — oil;

   — grease;

   — cellulosic paste containing water

b) The characteristics of the coupling medium shall remain constant throughout the verification, the setting operations and the testing.

c) If the constancy of the characteristics cannot be guaranteed between setting and testing, a transfer correction may be applied.

   One method for determining the necessary correction is described in ISO 16811.

   The coupling medium shall be suitable for the temperature range in which it will be used.

d) After testing is completed, the coupling medium shall be removed if its presence will adversely affect subsequent operations or use of the test object.

5.4 Standard blocks

The blocks which shall be used for setting the ultrasonic equipment are specified in ISO 2400 and ISO 7963.

The stability of the test equipment and the settings can be verified by using the blocks given in ISO 2400 and ISO 7963.

5.5 Reference blocks

a) When amplitudes of echoes from the test object are compared with echoes from a reference block, certain requirements relating to the material, surface condition, geometry and temperature of the block shall be observed.

b) Where possible, the reference blocks shall be made from a material with acoustic properties which are within a specified range with respect to the material to be tested and shall have a surface condition comparable to that of the test object.

c) If these characteristics are not the same, a transfer correction shall be applied.

A method for determining the necessary correction is described in ISO 16811.

d) The geometrical conditions of the reference blocks and the test object shall be considered.

For further details, see ISO 16811.

e) The geometry of the reference blocks, its dimensions, and the position of any reflectors, shall be indicated on a case by case basis in the specific standards and specifications.

f) The position and number of reflectors shall relate to the scanning of the entire test volume.

g) The most commonly used reflectors are:

1) large planar reflectors, compared to the beam width, perpendicular to the beam axis (e.g. back wall);

2) flat-bottomed holes;

3) side-drilled holes;

4) grooves or notches of various cross-sections.

h) When reference blocks are submerged, e.g. for immersion testing, the influence of water in the holes shall be considered or the ends of the holes shall be plugged.

i) The consequences of temperature differences between test object, probes, and reference blocks shall be considered and compared to the requirements for the accuracy of the test.

j) If necessary, the reference blocks shall be maintained within the specified temperature range during the testing.

5.6 Specific test blocks

In certain cases, specific blocks, e.g. with identified natural discontinuities, can be used to optimise the test technique and to check the stability of the test sensitivity.

6 Principles of testing

6.1 Basic techniques and setup

In its simplest application two probes, one emitting and the second receiving, are placed so that the receiving probe receives the sound transmitted through the test object. This can be achieved with straight-beam probes or angle-beam probes, see Figure 1, b), d), f), and h).