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Non-destructive testing — Ultrasonic testing — Reference blocks and test procedures for the characterization of contact probe sound beams

Essais non destructifs — Contrôles par ultrasons — Blocs de référence et modes opératoires des essais pour la caractérisation des faisceaux des traducteurs utilisés dans les contrôles par contact

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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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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 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*.

This second edition cancels and replaces the first edition (ISO 12715:1999), which has been technically revised.

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Introduction

In ultrasonic non-destructive testing, pulse-echo contact tests with a straight-beam probe (also known as a normal-beam probe), an angle-beam probe (also known as an angle probe), or a dual-element probe (also known as a twin-crystal probe) are often used. To reliably detect and characterize a reflector inside a material, knowledge of the sound beam (or the beam profile) generated by the probe in contact with the test object is needed. This International Standard establishes two metal reference blocks to be adopted for various metals such as forged or rolled steel, aluminium, and titanium alloy products. The frequency range of the probes used in this International Standard range from 1 MHz to 15 MHz. Depending on the structure of the materials under evaluation, in general, 1 MHz to 5 MHz is most suitable for steel products and 5 MHz to 15 MHz is most suitable for aluminium and titanium alloys.

The two reference blocks introduced are the hemicylindrical-stepped (HS) and the side-drilled-hole (SDH) types, by which the beam profiles generated by straight-beam, focused beam, angle-beam, and dual-element probes can be measured. This International Standard establishes the techniques and procedures to be used for the characterization of probe beam profiles in metals.

In pulse-echo ultrasonic tests, the reflected pulse (echo) is used for the detection of discontinuities existing in a material. The discontinuities (such as porosity, voids, or cracks in different sizes and shapes) can be located close to the surface or deep inside, or close together and oriented at different angles. An ultrasonic pulse incident on such discontinuities can reflect or refract into longitudinal (also known as compressional) or transverse (also known as shear) waves, or both, possibly with multiple reflections and refractions. In order to accurately characterize the location, size, and shape of a discontinuity inside a material, it is necessary to know the sound beam transmitted and received by the probe and the instrument.

The sound beam inside a solid produced by a probe in contact testing depends on the type, size, and frequency bandwidth of the probe as well as other parameters such as focusing, beam angle of refraction in the test object, material properties, and characteristics of the ultrasonic instrument.

ISO 2400 establishes a steel reference block, known as calibration block No. 1. For straight-beam tests, this block is used, for example, for checking or establishing the near-field resolution, far-field resolution, and time base (or horizontal) linearity of the test equipment. For angle-beam tests, the block is used to determine the probe index point (probe index) and the angle of refraction (beam angle). This block also provides a means for determining the longitudinal (compressional) wave and transverse (shear) wave velocities of the material under test.

ISO 7963 establishes a small steel block, known as the calibration block No. 2, which is quite suitable for field use. ISO 7963 provides guidelines for material selection, preparation, and mechanical tolerances of the reference block. It also provides procedures for testing the angle of refraction and sensitivity settings of the signals.

The sound beam of a straight-beam probe (normal-beam probe) can be calculated or measured in immersion testing with the procedures given in ISO 10375.

In addition to ISO 2400 and ISO 7963, this International Standard introduces two ultrasonic reference blocks and provides a general methodology of using these blocks in order to establish the sound beams or beam profiles in contact tests.

The objectives of this International Standard are to

— determine probe axes so that consistent tests can be performed,

— establish a complete sound beam profile inside metals for probes of both types, straight-beam and angle-beam, including focused beam and dual-element probes,

— provide a method for calculating the correct angle of refraction when an angle-beam probe designed for use in steel is to be used in materials other than steel,

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— provide a beam profile measurement capability for future applications, such as an electromagnetic acoustical transducer (EMAT),

— provide a capability for lateral angle-beam profile measurements,

— provide means for time base calibration with angle-beam probes to be used with ultrasonic imaging systems (see Annex A),

— provide means for time-of-flight (TOF) beam profile measurements for probes to be used with ultrasonic imaging systems (see Annex B),

— provide a technique by hand-held method and by using a mechanical scanner and UT imaging system to obtain both the amplitude and TOF beam profiles (see Figure B.1), and

— provide means for the determination of the skew (or squint) angle, far-field and near-field resolution of angle-beam probes (see Annex C).

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Non-destructive testing — Ultrasonic testing — Reference blocks and test procedures for the characterization of contact probe sound beams

1 Scope

This International Standard introduces two metal reference blocks, the hemicylindrical-stepped (HS) block and the side-drilled-hole (SDH) block. This International Standard establishes procedures for measuring the sound beam profiles generated by probes in contact with the test object. The probes include straight-beam, angle-beam (refracted compressional and refracted shear wave), focused beam, and dual-element probes. The side dimension of the probe has to be no greater than 25 mm.

The methodology of this International Standard provides guidelines for probes to be used for different metals including forged or rolled steel, aluminium, or titanium alloy products. The frequency range of the probes used in this International Standard extends from 1 MHz to 15 MHz, where 1 MHz to 5 MHz is best suited for steels and 5 MHz to 15 MHz is best for fine grain structured alloys such as aluminium products.

If this International Standard is to be used for materials other than steels, users should be aware of the fact that the wave velocities in these materials can be different from that of steels and the angle-beam probes are normally designed based on the steel applications. Snell's law of refraction is described in this International Standard so that correct angles of refraction in other homogeneous and fine-grained materials can be calculated. This International Standard applies to angle-beam probes of all practical angles (0° to 70°) and to focused and dual-element probes. This International Standard does not address the use of surface (Rayleigh) wave probes.

This International Standard does not address the estimation of equivalent defect sizes which requires reference blocks with flat-bottomed holes. This International Standard establishes no acceptance criteria, but does establish the technical basis for criteria that can be defined by users.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 inspection — Vocabulary*

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

3 Terms and definitions

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

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