INTERNATIONAL ISO

Second edition
2014-06-15

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

Reference number
ISO 12715:2014(E)

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Published in Switzerland

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Foreword

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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.

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,

— 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).

