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Non-destructive testing — Ultrasonic testing — Sensitivity and range setting

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Contents

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iii

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vii

Foreword

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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 16811:2012), which has been technically revised.

The main changes are as follows:

— normative references have been updated;

— Annex A and Annex B from the prior edition have been moved to the main text;

— document has been editorially revised.

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~~www.iso.org/members.html.

Introduction

The following documentsstandards on ultrasonic testing 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[1].

[1] It is intended to modify the title of the standard to become *Non-destructive testing — Ultrasonic testing — Time-of-flight diffraction technique for detection and sizing of discontinuities* during the next revision of the standard.

Non-destructive testing — Ultrasonic testing — Sensitivity and range setting

1 Scope

This document specifies the general rules for setting the time-base range and sensitivity (i.e. gain adjustment) of a manually operated ultrasonic instrument with A-scan display in order that reproducible determinations can be made of the location and echo height of a reflector.

~~It~~This document is applicable to contact techniques employing a single probe with either a single transducer or dual transducers~~, but excludes~~. This document does not apply to the immersion technique and techniques employing more than one probe.

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*[2]

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

ISO 7963, *Non-destructive testing — Ultrasonic testing — Specification for calibration block No. ~~2~~*[~~3~~]*2*[1)]

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

[2] ~~With~~In the next revision of the standard, the term "calibration block" is intended to be replaced by the term "standard block".

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~~https://www.iso.org/obp

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

4 Quantities and symbols

A full list of the quantities and symbols used throughout this document is given in Table 1.

Table 1 — Quantities and symbols

Symbol	Quantity	Unit
A	Normalized distance in DGS diagram	
A'	Probe coordinate	mm
a	Projected sound path length	mm
a'	Reduced projected sound path length	mm
α	Beam angle in steel	°
α_r	Beam angle in a non-alloy steel reference block or wedge	°
α_d	Incident angle (beam angle in delay block)	°
α_t	Beam angle in test object	°
β	Angle of incidence	°
c_r	Sound velocity in reference block	m/s
c_t	Velocity of transverse waves in test object	m/s
c_d	Velocity of longitudinal waves in delay block or wedge	m/s
D_{obj}	Outer diameter of test object or curvature of scanning surface	mm
d	Wall thickness	mm
D_{eff}	Effective transducer size	mm
D_{SSH}	Diameter of spherical-shaped reflector	mm
D_{DSR}	Diameter of disc-shaped reflector	mm
D_{ps}	Diameter of probe shoe	mm
D_{SDH}	Diameter of side-drilled hole	mm
e_1 to e_7	Reference block dimensions	mm
g	Depth of contour on probe contact surface	mm
G	Normalized diameter of disc-shaped reflector in DGS-Diagram	
λ	Wavelength	mm
ΔH_u	Difference between the echo height from a reference reflector and the echo height from a discontinuity	dB
l_{ps}	Length of probe shoe	mm
l_d	Length of delay path	mm
Δl_{ps}	Length of contoured probe face	mm

Symbol	Quantity	Unit
N_{eff}	Effective near field length	mm
P_r	Reference point at s_{max}	
P_j	Reference point at s_j	
q	Coordinate of reflector	mm
s	Sound path length (single trip)	mm
s_d	Equivalent sound path distance in the delay block	
s_j	Sound path length of reference reflector	mm
s_{max}	Maximum sound path length	mm
s_u	Sound path length associated with evaluated signal	mm
s_v	Acoustic equivalent to delay path in test object	mm
t	Depth coordinate of reflector	mm
V	Gain in DGS diagram	dB
V_j	Basic gain	dB
V_r	Recording gain	dB
V_t	Gain for determining ΔV_t	dB
V_u	Indication gain	dB
ΔV	Gain difference	dB
$\Delta V_{\sim}$	Correction for ΔV_t	dB
ΔV_k	Gain correction for cylindrical reflector surface	dB
ΔV_s	Gain difference associated with sound path length	dB
ΔV_t	Transfer correction (average)	dB
$V_{t,r}$	Gain for back wall echo on reference block	dB
$V_{t,t}$	Gain for back wall echo on test object	dB
ΔV_u	Difference between indication gain and recording gain	dB
w_{ps}	Width of probe shoe	mm
Δw_{ps}	Width of contouring of the probe face	mm
x	Distance between probe index point and front edge of probe, for an uncontoured probe	mm
Δx	Probe index shift	mm

5 Qualification of personnel

a) The testing shall be performed by personnel qualified in accordance with ISO 9712.

b) The requirements for qualification of test personnel shall be specified in the product standards and/or other applicable documents.

6 Test equipment

6.1 Instrument

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

6.2 Probes

6.2.1 General

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

6.2.2 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 6.2.2, 6.2.3 and 6.2.4 shall be considered in relation to the characteristics of the test object stated above.

6.2.3 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 to detect planar discontinuities that are unfavourably orientated.

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

The higher the frequency, the greater the test 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 represents a compromise between these two factors.

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