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Non-destructive testing — Characterization and verification of ultrasonic phased array equipment~~—~~ —

Part 3:
Complete systems

~~Essais non destructifs — Caractérisation et vérification de l'appareillage ultrasonore multiélément — Partie 3: Système complet~~

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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 18563-3:2015), which has been technically revised.

The main changes are as follows:

— ~~—~~integration of matrix array probes;

— ~~—~~deletion of group 1 and 2 tests;

— ~~—~~addition of a clause on the use of imaging for complete system verification ~~(9.4.3)~~(9.4.3) as a simplification for a more functional standard (characterisation of beams moved to ~~Annex A)~~,Annex A);

— ~~—~~addition of signal processing techniques using arrays (e.g. ~~Total Focusing Technique~~total focusing technique (TFM)) in the scope.

A list of all parts in the ISO 18563 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.

Field Code Changed

Non-destructive testing — Characterization and verification of ultrasonic phased array equipment

Part 3: Complete ~~system~~systems

1 Scope

This document addresses ultrasonic test systems implementing array probes, for contact technique (with or without wedge) or for immersion technique, with centre frequencies in the range of 0,5 MHz to 10 MHz.

This document provides methods and acceptance criteria for determining the compliance of the complete system (see ~~3.2).~~3.2). Its purpose is for the verification of the correct operation of the system prior to testing or verification of the absence of degradation of the system.

The methods are not intended to prove the suitability of the system for particular applications but are intended to prove the capability of the complete system (used for an application) to operate correctly according to the settings used. Tests can be performed on individual ultrasonic beams (for phased array technique, see ~~9.4.4)~~9.4.4) or on resulting images (for phased array technique and total focusing technique, see ~~9.4.3).~~9.4.3).

The tests can be limited to the functions that are intended to be used for a certain application.

This document does not cover the sensitivity setting of the system for a specific application. Nor does it apply to the characterization or verification of the mechanical scanning equipment. It is intended that these items will be covered by the test procedure.

This document does not address the phased array technique using tandem technique.

The characterization of beams, as recommended in case of dead elements or for more in-depth knowledge of the beams, is presented in ~~Annex A.~~Annex A. It is not applicable for signal processing technology using arrays.

NOTE Unless stated otherwise, in this document 'TFM' and 'TFM technique' refer to the total focusing technique as defined in ISO 23243, and to related techniques, see for example ISO 23865 and ISO 23864.

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

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 18563-1, *Non-destructive testing — Characterization and verification of ultrasonic phased array equipment — Part 1: Instruments*

ISO 18563-2, *Non-destructive testing — Characterization and verification of ultrasonic phased array equipment — Part 2: Probes*

ISO 22232-~~-~~2, *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 2: Probes*

ISO 23243, *Non-destructive testing — Ultrasonic testing with arrays — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577, ISO 23243 and the following apply.

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/

3.1
combined equipment
connected set including the instrument, the array probe (with wedge if applicable) and connecting cables, including adapters

[SOURCE: ISO 23243:2020. Modified – array and wedge added]

3.2
complete system
combined equipment including the settings for a given mode of operation

Note- 1- to- entry:- Settings are specific values or ranges of values, e.g. electronic scanning or steering range.

3.3
reference system
complete system, including an instrument according to ISO 18563-1 and an array probe initially according to ISO 18563-2, on which all of the applicable tests defined in ~~Clause 9~~Clause 9 of this document have been performed successfully

3.4
identical system
complete system in which instrument, array probe, wedge, connecting cables and the settings for a given mode of operation are identical to those of the reference system

Note- 1- to- entry:- Components are identical if from the same manufacturer and the same model.

3.5
system record sheet
document for reporting the results for a complete system which enables a comparison with the values obtained from the reference system

4 Symbols

For the purposes of this document, the symbols given in ~~Table 1~~Table 1 apply.

Table 1- — Symbols

Symbol	Unit	Definitions
$(X_C; Z_C)$	mm; mm	Coordinates of the position of the centre of the reference reflector
$(X_M; Z_M)$	mm; mm	Coordinates of the position of maximum amplitude of an indication
A_{el}	V or % FSH	Amplitude of one elementary signal
a_i	mm	*Contact technique*: reduced projected sound path length *Immersion technique*: distance between the orthogonal projection of the axis of the side-drilled hole on the test surface and the centre of the probe front surface
A_{max}	V or % FSH	Maximum value of the amplitudes of all elementary signals
A_{min}	V or % FSH	Minimum value of the amplitudes of all elementary signals, excluding the dead elements
A_{ref}	V or % FSH	Median value of the amplitudes of all elementary signals
D	mm	Diagonal of the active aperture
D_{CM}	mm	Distance between the centre of a side-drilled hole and the point of maximum amplitude of the indication of this hole
G_{ref}	dB	Reference gain
N	mm	Near-field length associated with the active aperture
p	mm	Pitch
X_s	mm	Distance between the probe front surface and the probe index point for the studied beam
ΔS_{el}	dB	Relative sensitivity of an element
Θ	°	Angle of refraction
λ	mm	Wavelength

~~6~~5 General requirements for conformity

~~6.1~~5.1 General

All following tests shall be performed with an instrument that complies with ISO 18563-1 and an array that initially complied with ISO 18563-2.

The tests can be limited to the functions that are intended to be used for a certain application, e.g. used channels of the instrument or used part of the array or specific settings for a specified mode of operation.

When all required tests have been successfully conducted, the complete system is considered to conform to this document.

~~6.2~~5.2 Reference system

a) ~~a)~~ The tests to be performed prior to the first use of a complete system are described in ~~Table 4.~~Table 4.

When all required tests have been successfully conducted, this complete system may be used as a reference system. The results of the measurements made are the base values.

b) ~~b)~~ A system record sheet of these base values shall be created.

~~6.3~~5.3 Identical system

a) ~~a)~~ When an identical system is created, and/or when using other channels of the instrument and duplicating the settings, or after a maintenance operation or after the replacement of a system component, the tests as described in ~~Table 4~~Table 4 shall be performed again.

b) ~~b)~~ The results of the measurements made on the identical system shall be recorded in the system record sheet and compared against the base values.

~~6.4~~5.4 Periodic checks

a) ~~a)~~ For a periodic check of correct operation of the system, the tests as described in ~~Table 4~~Table 4 shall be performed again.

b) ~~b)~~ The frequency of checking of the complete system shall be specified in the test procedure, e. g. before starting and at the end of the non-destructive testing or daily, weekly, monthly, depending on the application.

c) ~~c)~~ Each periodic check shall be documented on the system record sheet, either by recording the values of the checks or by stating that the results are within the acceptance criteria.

~~7~~6 Qualification of test personnel

a) 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.

b) In addition to general knowledge of ultrasonic testing, the operators shall be familiar with, and have practical experience in, the use of the ultrasonic phased array technique or the total focusing technique (TFM).

~~8~~7 Modes of operation for phased array techniques

This clause is not applicable for signal processing techniques using arrays, e.g. TFM.

This clause is applicable for phased array techniques based on beams by using a set of delay laws for multiple array elements during transmission and/or reception.

Depending on the application, the following options of the phased array technique may be used:

— ~~—~~number of active apertures (one or multiple);

— ~~—~~number of shots or delay laws (one or multiple) per active aperture;

— ~~—~~type of delay law (beam steering, beam focusing or combined setting).

The six most common modes of operation for phased array techniques are defined in ~~Table 2~~Table 2.

Examples of modes of operation for phased array techniques are illustrated in ~~Table 3~~Table 3.

Table 2 — Definition of modes of operation for phased array techniques