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Non-destructive testing of welds — Ultrasonic testing — Use of time-of-flight diffraction technique (TOFD)

Essais non destructifs des assemblages soudés — Contrôle par ultrasons — Utilisation de la technique de diffraction des temps de vol (TOFD)

Reference number
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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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds.*

This second edition cancels and replaces the first edition (ISO 10863:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the whole document has been updated to the state of the art; ISO 22232 series has been taken into account;

— Clause 3 has been updated;

— Figure 1 to Figure 6 have been added;

— Figure B.1 to Figure B.18 have been updated.

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.

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

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Non-destructive testing of welds — Ultrasonic testing — Use of time-of-flight diffraction technique (TOFD)

1 Scope

This document specifies the application of the time-of-flight diffraction (TOFD) technique to the semi- or fully automated ultrasonic testing of fusion-welded joints in metallic materials of minimum thickness 6 mm.

It applies to full penetration welded joints of simple geometry in plates, pipes, and vessels, where both the weld and the parent material are low-alloyed carbon steel. Where specified and appropriate, TOFD can also be used on other types of materials that exhibit low ultrasonic attenuation (especially that due to scatter).

Where material-dependent ultrasonic parameters are specified in this document, they are based on steels having a sound velocity of (5 920 ± 50) m/s for longitudinal waves and (3 255 ± 30) m/s for transverse waves. It is necessary to take this fact into account when testing materials with a different velocity.

This document makes reference to ISO 16828 and provides guidance on the specific capabilities and limitations of TOFD for the detection, location, sizing and characterization of discontinuities in fusion-welded joints. TOFD can be used as a stand-alone method or in combination with other non-destructive testing (NDT) methods or techniques, for manufacturing inspection, and for in-service inspection.

This document specifies four testing levels (A, B, C, D) in accordance with ISO 17635 and corresponding to an increasing level of testing reliability. Guidance on the selection of testing levels is provided.

This document permits assessment of TOFD indications for acceptance purposes. This assessment is based on the evaluation of transmitted, reflected and diffracted ultrasonic signals within a generated TOFD image.

This document does not include acceptance levels for discontinuities.

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

ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment*

ISO 22232-1[1)], *Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 1: Instruments*

1) Under preparation. (Preparation at the time of publication: ISO/FDIS 22232-1.)

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ISO 22232-2[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 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
time-of-flight diffraction image
TOFD image
two-dimensional image, constructed by collecting adjacent A-scans while moving the *time-of-flight diffraction setup* (3.3)

Note 1 to entry: The signal amplitude of the A-scans is typically represented by grey-scale values.

3.2
time-of-flight diffraction indication
TOFD indication
pattern or disturbance in the *time-of-flight diffraction image* (3.1) which can need further evaluation

3.3
time-of-flight diffraction setup
TOFD setup
probe arrangement defined by probe characteristics (e.g. frequency, probe element size, beam angle, wave mode) and *probe centre separation* (3.6)

3.4
beam intersection point
point of intersection of the two main beam axes

3.5
lateral wave
longitudinal wave traveling the shortest path from transmitter probe to receiver probe

3.6
probe centre separation
PCS
distance between the index points of the two probes

Note 1 to entry: The PCS for two probes located on a curved surface is the straight-line, geometric separation between the two probe index points and not the distance measured along the surface.

3.7
offset scan
scan parallel to the weld axis, where the *beam intersection point* (3.4) is not on the centreline of the weld

4 General remarks on the capabilities of the technique

General principles of the TOFD technique are described in ISO 16828. For the testing of fusion-welded joints, some specific capabilities and limitations of the technique shall be considered.

2) Under preparation. (Preparation at the time of publication: ISO/DIS 22232-2.)

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