



SLOVENSKI STANDARD
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Neporušitveno preskušanje zvarnih spojev - Ultrazvočno preskušanje - Uporaba avtomatske tehnike s faznim krmiljenjem (FA-tehnika) (ISO/DIS 13588:2018)

Non-destructive testing of welds - Ultrasonic testing - Use of automated phased array technology (ISO/DIS 13588:2018)

Zerstörungsfreie Prüfung von Schweißverbindungen - Ultraschallprüfung - Anwendung von automatisierter phasengesteuerter Array-Technologie (ISO/DIS 13588:2018)

Contrôle non destructif des assemblages soudés - Contrôle par ultrasons - Utilisation de la technique multi-éléments automatisés (ISO/DIS 13588:2018)

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Non-destructive testing of welds — Ultrasonic testing — Use of automated phased array technology

Contrôle non destructif des assemblages soudés — Contrôle par ultrasons — Utilisation de la technique multi-éléments automatisés

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ISO/DIS 13588:2018(E)**Foreword**

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

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Non-destructive testing of welds — Ultrasonic testing — Use of automated phased array technology

1 Scope

This document specifies the application of the phased array technology for 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 material-dependent ultrasonic parameters are specified in this document, they are based on steels having a sound velocity of $(5\,920 \pm 50)$ m/s for longitudinal waves, and $(3\,255 \pm 30)$ m/s for transverse waves. It is necessary to take this fact into account when testing materials with different velocities. Steels with other velocities should be tested under testing level D.

For coarse-grained or austenitic steels ISO 22825 applies.

This document provides guidance on the specific capabilities and limitations of the phased array technology for the detection, location, sizing and characterization of discontinuities in fusion-welded joints. Phased array technology can be used as a stand-alone technology or in combination with other non-destructive testing (NDT) methods or techniques, for manufacturing inspection, pre-service and for in-service inspection.

This document specifies four testing levels, each corresponding to a different probability of detection of imperfections.

This document permits assessment of discontinuities for acceptance purposes based on either amplitude (equivalent reflector size) and length or on height and length.

This document does not include acceptance levels for discontinuities.

This document is not applicable for automated testing of welds during the production of steel products covered by ISO 10893-8, ISO 10893-11 and ISO 3183.

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 17635, *Non-destructive testing of welds — General rules for metallic materials*

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

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*

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ISO 18563-3, *Non-destructive testing — Characterization and verification of ultrasonic phased array equipment — Part 3: Combined systems*

ISO 19285, *Non-destructive testing of welds — Phased array ultrasonic testing (PAUT) — Acceptance levels*

ISO 22825, *Non-destructive testing of welds — Ultrasonic testing — Testing of welds in austenitic steels and nickel-based alloys*

EN 16018, *Non-destructive testing — Terminology — Terms used in ultrasonic testing with phased arrays*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and EN 16018 and the following apply.

3.1**phased array image**

one- or two-dimensional display, constructed from the collected information of phased array operation

3.2**phased array indication**

pattern or disturbance in the phased array image which may need further evaluation

3.3**phased array set-up**

probe arrangement defined by probe characteristics (e.g. frequency, probe element size, beam angle, wave mode), probe position, and the number of probes

3.4**probe position****PP**

distance between the front of the wedge and the weld centre line

3.5**scan increment**

distance between successive data collection points in the direction of scanning (mechanically or electronically)

3.6**skewed scan**

scan performed with a skewed angle

Note 1 to entry: The skewed angle can be achieved electronically or by means of probe orientation.

4 Testing level

Quality requirements for welded joints are mainly associated with the material, welding process and service conditions. To accommodate all of these requirements, this document specifies four testing levels (A, B, C, and D).

From testing level A to testing level C, an increasing probability of detection is achieved by an increasing testing coverage, e.g. number of incidences, combining techniques.

Testing level D may be agreed for special applications using a written procedure which shall take into account the general requirements of this document. This includes tests of metals other than ferritic steel, tests on partial penetration welds, tests with automated equipment and tests at object temperatures outside the range.

In general, the testing levels are related to quality levels (e.g. according to ISO 5817). The appropriate testing level can be specified by standards for the testing of welds (e.g. ISO 17635), by product standards or by other documents. When ISO 17635 is specified, the recommended testing levels are as given in Table 1.

Table 1 — Recommended testing levels

Testing level	Quality level in ISO 5817
A	C, D
B	B
C	by agreement
C	special application

Table 2 shows the minimum requirements and in all cases as described in 7.2 the set-up shall be verified with a reference block. In cases where scanning is performed from one face (excluding TOFD), half and full skip shall be used and stored; if scanning is performed from both faces, half skip is sufficient.

If the evaluation of the indications is based on amplitude only, the deviation from the normal to the weld shall not exceed 6°.

Table 2 — Description of testing levels

Mode	Testing levels			Example of sketches
	A	B	C	
	Reference blocks (see Annex A)			
	Block A	Block B	Block C	
Test set-up				
Fixed angles at fixed probe position to weld (line scans) ^a	Two sides	Not suitable as single technique	Two sides	
Fixed angles with raster scanning ^a	One side	One side	One side	
E-scan at fixed probe position (line scan) ^a	One side	Two sides with two angles ^c	Two sides	
S-scan at fixed probe position to weld (line scan) ^a	One side	Two sides or two probe positions	Two sides or two probe positions	
S-scan raster	Not recommended		One side	
TOFD generated with phased array ^a	Not recommended, TOFD testing in accordance with ISO 10863		One set-up	
Skewed scan ^b	If required by specification			
<p>^a For testing level C, at least two different test set-ups from this table shall be combined; at least one of them shall be S-scan or TOFD.</p> <p>^b If detection of transverse discontinuities is required by specification, a suitable additional test set-up shall be applied. Skewed probe or electronically skewed beam can be used.</p> <p>^c At least 10° difference between angles.</p>				

5 Information required prior to testing

5.1 Items to be defined prior to procedure development

Information on the following items is required:

- purpose and extent of testing;
- testing levels;
- acceptance criteria;
- specification of reference blocks;
- manufacturing or operation stage at which the testing is to be carried out;
- weld details and information on the size of the heat-affected zone;

- g) requirements for access and surface conditions and temperature;
- h) personnel qualifications;
- i) reporting requirements.

5.2 Specific information required by the operator before testing

Before any testing of a welded joint can begin, the operator shall have access to all the information as specified in 5.1 together with the following additional information:

- a) written test procedure;
- b) type(s) of parent material and product form (i.e. cast, forged, rolled);
- c) joint preparation and dimensions;
- d) welding instruction or relevant information on the welding process;
- e) time of testing relative to any post-weld heat treatment;
- f) result of any parent metal testing carried out prior to and/or after welding.

5.3 Written test procedure

For all testing levels a written test procedure is required.

A procedure shall be written and shall include the following information as a minimum:

- g) the purpose and extent of testing;
- h) testing techniques;
- i) testing levels;
- j) personnel qualification/training requirements;
- k) equipment requirements (including but not limited to frequency, sampling rate, pitch between elements, element size);
- l) reference and/or test blocks;
- m) the setting of equipment;
- n) available access and surface conditions;
- o) the testing of parent material;
- p) the evaluation of indications;
- q) acceptance levels and/or recording levels;
- r) reporting requirements;
- s) environmental and safety issues.

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The procedure shall include a documented testing strategy or scan plan showing probe placement, movement, and component coverage that provides a standardized and repeatable methodology for weld testing. The scan plan shall also include ultrasonic beam angles used, beam directions with respect to the weld centre line, and the volume to be tested for each weld.

6 Requirements for personnel and test equipment

6.1 Personnel qualifications

Personnel performing testing in accordance with this document shall be qualified to an appropriate level in accordance with ISO 9712 or equivalent in the relevant industrial sector.

In addition to a general knowledge of ultrasonic weld testing, the operators shall be familiar with and have practical experience in the use of ultrasonic phased arrays. Specific training and examination of personnel should be performed on representative pieces. These training and examination results should be documented. If this is not the case, specific training and examination should be performed with the finalized ultrasonic testing procedures and selected ultrasonic test equipment on representative samples containing natural or artificial reflectors similar to those expected. These training and examination results should be documented.

6.2 Test equipment

6.2.1 General

In selecting the system components (hardware and software) ISO TS 16829 gives useful information.

6.2.2 Ultrasonic equipment and display

Ultrasonic equipment used for the phased array testing should be in accordance with the requirements of ISO 18563-1, ISO 18563-2, and ISO 18563-3 when applicable.

The equipment shall be able to select an appropriate portion of the time base within which A-scans are digitized.

It is recommended that a sampling rate of the A-scan be used of at least six times the nominal probe frequency.

6.2.3 Ultrasonic probes

Both longitudinal and shear wave modes may be used.

Adaptation of probes to curved scanning surfaces shall comply with ISO 17640. When adapted probes are used, the influence on the sound beam shall be taken into account.

6.2.4 Scanning mechanisms

To achieve consistency of the images (collected data), guiding mechanisms and scan encoder(s) shall be used.