SLOVENSKI STANDARD
oSIST prEN ISO 16827:2024

01-april-2024

Neporušitvene preiskave - Ultrazvočne preiskave - Karakterizacija in velikosti nezveznosti (ISO/DIS 16827:2024)

Non-destructive testing - Ultrasonic testing - Characterization and sizing of discontinuities (ISO/DIS 16827:2024)

Zerstörungsfreie Prüfung - Ultraschallprüfung - Beschreibung und Größenbestimmung von Inhomogenitäten (ISO/DIS 16827:2024)

Essais non destructifs - Contrôle par ultrasons - Caractérisation et dimensionnement des discontinuités (ISO/DIS 16827:2024)

Ta slovenski standard je istoveten z: prEN ISO 16827

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

oSIST prEN ISO 16827:2024 en,fr,de

DRAFT International Standard

ISO/DIS 16827

ISO/TC **135**/SC **3**

Secretariat: **DIN**

Voting begins on:
2024-02-23

Voting terminates on:
2024-05-17

Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities

Essais non destructifs — Contrôle par ultrasons — Caractérisation et dimensionnement des discontinuités

ICS: 19.100

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 16827:2024(en)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*.

This second edition cancels and replaces the first edition (ISO 16827:2012), which has been technically revised.

The main changes are as follows:

— figures have been updated,

— references have been updated,

— a hint has been added in the scope that the technique can also be used with phased array.

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.

Introduction

The following documents 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 — 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*

Non-destructive testing — Ultrasonic testing — Characterization and sizing of discontinuities

1 Scope

This document specifies the general principles and techniques for the characterization and sizing of previously detected discontinuities in order to ensure their evaluation against applicable acceptance criteria.

It is applicable, in general terms, to discontinuities in those materials and applications covered by ISO 16810.

Phased array techniques may also be applied but additional steps or verifications can be needed.

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 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 — Transmission technique*

ISO 23279, *Non-destructive testing of welds — Ultrasonic testing — Characterization of discontinuities in welds*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 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

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

4 Principles of characterization of discontinuities

4.1 General

Characterization of a discontinuity involves the determination of those features which are necessary for its evaluation with respect to specified acceptance criteria.

Characterization of a discontinuity may include:

a) determination of basic ultrasonic parameters (echo height, time of flight);

b) determination of its basic shape and orientation;

c) sizing, which may take the form of either:

   1) the determination of one or more dimensions (or area/volume), within the limitations of the methods; or

   2) the determination of some specified parameter, e.g. echo height, where this is taken as representative of the physical size of the discontinuity;

d) location, e.g. the proximity to the surface or to other discontinuities;

e) determination of any other parameters or characteristics that may be necessary for complete evaluation;

f) assessment of probable nature, e.g. crack or inclusion, where adequate knowledge of the test object and its manufacturing history makes this feasible.

g) The requirements of ISO 16810 apply unless stated otherwise.

   Where the test in accordance with the principles of ISO 16810 yields sufficient data on the discontinuity for its evaluation against the applicable acceptance criteria, no further characterization is necessary.

h) The techniques used for characterization shall be specified in conjunction with the applicable acceptance criteria.

4.2 Requirements for surface condition

a) The surface finish and profile shall be such that it permits sizing of discontinuities with the desired accuracy.

   In general the smoother and flatter the surface the more accurate the results will be.

   For most practical purposes a surface finish of *Ra* = 6,3 µm for machined surfaces and 12,5 µm for shot-blasted surfaces are recommended.

b) The gap between the probe and the surface shall not exceed 0,5 mm.

c) The above surface requirements shall normally be limited to those areas from which sizing is to be carried out as, in general, they are unnecessary for discontinuity detection.

d) The method of surface preparation shall not produce a surface that gives rise to a high level of noise.

5 Pulse-echo techniques

5.1 General

The principal ultrasonic characteristics/parameters of a discontinuity that are most commonly used for evaluation by the pulse-echo techniques are described in 5.2 to 5.7 inclusive.

The characteristics/parameters to be determined shall be defined in the applicable standard or any relevant contractual document, and shall meet the requirements of ISO 16810:2012, 10.1.

5.2 Location of discontinuity

The location of a discontinuity is defined as its position within a test object with respect to an agreed system of reference co-ordinates.

a) It shall be determined in relation to one or more datum points and with reference to the index point and beam angle of the probe, and measurement of the probe position and sound path length at which the maximum echo height is observed.

b) Depending on the geometry of the test object and the type of discontinuity, it may be necessary to confirm the location of the discontinuity from another direction, or with another beam angle, to ensure that the echo is not caused e.g. by a wave mode conversion at a geometrical feature of the test object.

5.3 Orientation of discontinuity

The orientation of a discontinuity is defined as the direction or plane along which the discontinuity has its major axis (axes) with respect to a datum reference on the test object.

a) The orientation can be determined by a geometrical reconstruction analogous to that described for location, with the difference that more beam angles and/or scanning directions are generally necessary than for a simple location.

b) The orientation may also be determined from observation of the scanning direction at which the maximum echo height is obtained.

c) In several applications, the precise determination of the discontinuity orientation in space is not required, only the determination of the projection of the discontinuity onto one or more specified planes and/or sections within the test object.

5.4 Assessment of multiple indications

The method for distinguishing between single and multiple discontinuities may be based on either qualitative assessment or quantitative criteria.

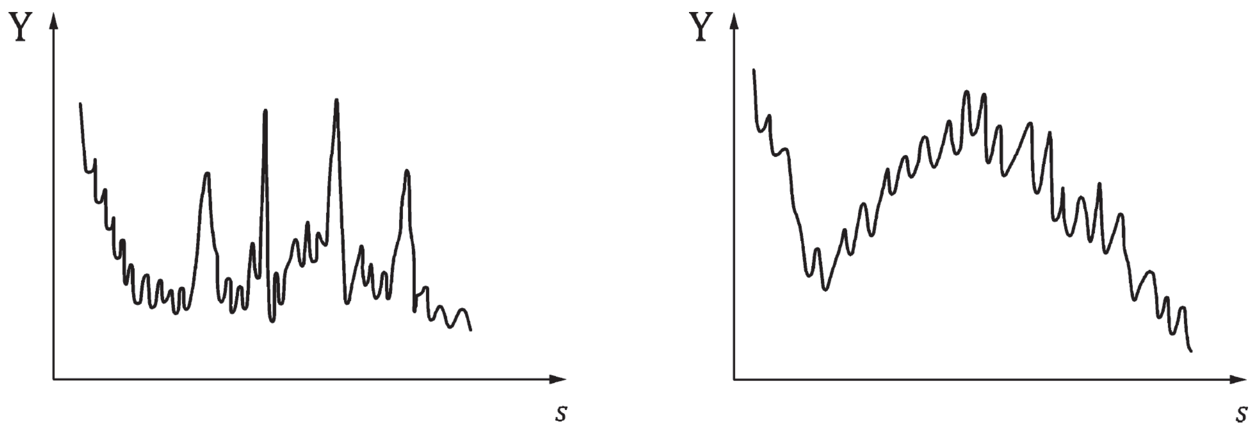
a) The qualitative determination consists of ascertaining, through the observation of the variations of the ultrasonic indications, whether or not such indications correspond to one or more separate discontinuities. Figure 1 shows typical examples of signals from grouped discontinuities in a forging or casting.

b) Where acceptance criteria are expressed in terms of maximum allowable dimensions, preliminary quantitative determinations shall be made in order to determine whether separate discontinuities are to be evaluated individually or collectively according to pre-established rules governing the evaluation of the group.

c) Such rules may be based on the concentration of individual discontinuities within the group, expressed in terms of the total of their lengths, areas or volumes in relation to the overall length, area or volume of the group.

Alternatively, the rules may specify the minimum distance between individual discontinuities, often as a ratio of the dimensions of the adjacent discontinuities.

d) Where a more accurate characterization of a group of indications is required, an attempt may be made to determine whether the echoes arise from a series of closely spaced but separate discontinuities, or from a single continuous discontinuity having a number of separate reflecting facets, using the techniques described in Annex A.



a) Resolvable grouped discontinuities **b) Unresolvable grouped discontinuities**

Key

s sound path

Y signal height

Figure 1 — Examples of A-scan signals from grouped discontinuities

5.5 Shape of discontinuity

5.5.1 Simple classification

There is a limited number of basic reflector shapes that can be identified by ultrasonic testing.

In many cases evaluation against the applicable acceptance criteria only requires a relatively simple classification, described in Clause B.1.

a) According to this, the discontinuity shall be classified as either:

   1) point, i.e. having no significant extent in any direction;

   2) elongated, i.e. having a significant extent in one direction only;

   3) complex, i.e. having a significant extent in more than one direction.

b) When required, this classification may be sub-divided into:

   1) planar, i.e. having a significant extent in 2 directions only, and

   2) volumetric, i.e., having a significant extent in 3 directions.

c) Depending upon the requirements of the acceptance standard, either:

   1) separate acceptance criteria may apply to each of the above classifications; or

   2) the discontinuity, independently of its point, elongated or complex configuration, is projected onto one or more pre-established sections, and each projection is conservatively treated as a crack-like planar discontinuity.

d) Simple classification will normally be limited to the use of those probes and techniques specified in the test procedure.

e) Additional probes or techniques shall only be used where agreed.

5.5.2 Detailed classification

a) In order to correctly identify the discontinuity types specified in the acceptance criteria, or to make a correct fitness-for-purpose evaluation, it may be necessary to make a more detailed assessment of the shape of the discontinuity.

Guidance on the methods that may be used for a more detailed classification is contained in Clause B.2.

It can require the use of additional probes and scanning directions to those specified in the test procedure for the detection of discontinuities, and can also be aided by the use of the special techniques in Annexes E, F and G.

b) Classification of discontinuity shape will be limited to the determination of those discontinuity shapes which are necessary for the correct evaluation of a discontinuity against the acceptance criteria or other requirements.

The validity of such a classification should be proven for the specific application, e.g. materials and configuration of the test object, test procedure, type of instrument and probes used.

5.6 Maximum echo height of indication

The maximum echo height from a discontinuity is related to its size, shape and orientation. It is measured by comparison with a specified reference level according to the methods described in ISO 16811.

Depending on the application and acceptance criteria the maximum echo height can be:

a) compared directly with a reference level that constitutes the acceptance standard;

b) used to determine the equivalent size of a discontinuity by comparison with the echo from a reference reflector at the same sound path length in the material under test, or in a reference block having the same acoustic properties, as described in 5.7.2;

c) used in probe movement sizing techniques based on a specified echo drop (e.g. 6 dB) below the maximum, as described in 5.7.3.

5.7 Size of discontinuity

5.7.1 General

The sizing of a discontinuity consists in determining one or more projected dimensions/areas of the discontinuity onto pre-established directions and/or sections.

A short description of these techniques is found in Annex F and further details are given in ISO 16811.

5.7.2 Maximum echo height techniques

These techniques are based on a comparison of the maximum echo height from a discontinuity with the echo height from a reference reflector at the same sound path range.

They are only meaningful if:

a) the shape and orientation of the discontinuity are favourable for reflection, hence the need to perform echo height determinations from several directions or angles, unless the shape and orientation are already known; and

b) the dimensions of the discontinuity, perpendicular to the beam axis, are less than the beam width in either one or both directions;

c) the basic shape and orientation of the reference reflector are similar to those of the discontinuity to be evaluated.

d) The reference reflector may be either a disc-shaped reflector, e.g. flat-bottomed hole or an elongated reflector, e.g. a side-drilled hole or notch.

e) Discontinuities subject to sizing may be classified as follows:

1) discontinuities whose reflective area has dimensions less than the beam width in all directions;

2) discontinuities whose reflective area shows a narrow, elongated form, i.e. having a length greater than the beam width and a transverse dimension less than the beam width.

f) For discontinuities corresponding to e) 1), the area of the discontinuity, projected onto a section normal to the ultrasonic beam axis, is assumed to be equivalent to the area of a disc-shaped reflector, perpendicular to the beam axis, producing a maximum echo of the same height at the same sound path range.

g) For discontinuities corresponding to e) 2), the reference reflectors are generally of elongated form, transverse to the ultrasonic beam axis, and having a specified transverse profile.

Such reflectors may be notches with rectangular, U- or V-shaped profile, or side-drilled holes.

5.7.3 Probe movement sizing techniques

a) When using a straight-beam probe the dimensions generally determined are l_1 and l_2, in directions parallel to the scanning surface, by probe movement in two mutually perpendicular directions (see Figure 2).

b) When using an angle-beam probe, the dimensions generally determined are:

1) dimension, l, parallel to the lateral scanning direction, determined by lateral movement of the probe (see Figure 3);

2) dimension, h, perpendicular to the scanning surface, determined by transverse movement of the probe (see Figure 3).

c) The techniques are classified into three categories, as follows:

1) fixed amplitude level techniques where the ends of a discontinuity are taken to correspond to the plotted positions at which the echo height falls below a specified evaluation level;

2) techniques where the edges of the discontinuity are taken to correspond to the plotted positions at which the maximum echo height at any position along the discontinuity has fallen by a specified number of decibels.

The edges of the discontinuity may be plotted along the beam axis or along a predetermined beam edge;

3) techniques which aim to position the individual echoes from the tips of the discontinuity, or from reflecting facets immediately adjacent to the edges.

The principal probe movement sizing techniques are described in Annex D.