SLOVENSKI STANDARD
oSIST prEN 12680-2:2024

01-maj-2024

Livarstvo - Ultrazvočno preskušanje - 2. del: Jekleni ulitki za močno obremenjene sestavne dele

Founding - Ultrasonic testing - Part 2: Steel castings for highly stressed components

Gießereiwesen - Ultraschallprüfung - Teil 2: Stahlgussstücke für hoch beanspruchte Bauteile

Fonderie - Contrôle par ultrasons - Partie 2: Pièces moulées en acier pour composants fortement sollicités

Ta slovenski standard je istoveten z: **prEN 12680-2**

ICS:

77.040.20	Neporušitveno preskušanje kovin	Non-destructive testing of metals
77.140.80	Železni in jekleni ulitki	Iron and steel castings

oSIST prEN 12680-2:2024 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 12680-2

January 2024

ICS 77.040.20; 77.140.80

Will supersede EN 12680-2:2003

English Version

Founding - Ultrasonic testing - Part 2: Steel castings for highly stressed components

Fonderie - Contrôle par ultrasons - Partie 2: Pièces moulées en acier pour composants fortement sollicités

Gießereiwesen - Ultraschallprüfung - Teil 2: Stahlgussstücke für hoch beanspruchte Bauteile

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 190.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. prEN 12680-2:2024 E

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European foreword

This document (prEN 12680-2:2023) has been prepared by Technical Committee CEN/TC 190 “Foundry technology”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12680-2:2003.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 10 “Testing for inner discontinuities” to prepare the following standard:

EN 12680-2, *Founding — Ultrasonic testing — Part 2: Steel castings for highly stressed components.*

This is one of three European Standards for ultrasonic testing. The other standards are:

EN 12680-1, *Founding — Ultrasonic testing — Part 1: Steel castings for general purposes.*

EN 12680-3, *Founding — Ultrasonic testing — Part 3: Spheroidal graphite cast iron castings.*

Annex A is normative. Annex B and Annex C are informative.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

1 Scope

This document specifies the requirements for the ultrasonic testing of steel castings (with ferritic structure) for highly stressed components and the methods for determining internal discontinuities by the pulse-echo technique. Purchasers determine if components are highly stressed based on the need for performance or safety.

This document applies to the ultrasonic testing of steel castings which have usually received a grain-refining heat treatment and which have wall thicknesses up to and including 600 mm.

For greater wall thicknesses, special agreements apply with respect to test procedure and recording levels.

This document does not apply to austenitic steels and joint welds.

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.

EN 1370, *Founding - Examination of surface condition*

EN ISO 2400, *Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 1 (ISO 2400)*

EN ISO 7963, *Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 2 (ISO 7963)*

EN ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712)*

EN ISO 16810, *Non-destructive testing - Ultrasonic testing - General principles (ISO 16810)*

EN ISO 16811, *Non-destructive testing - Ultrasonic testing - Sensitivity and range setting (ISO 16811)*

EN ISO 16826 *Non-destructive testing - Ultrasonic testing - Examination for discontinuities perpendicular to the surface (ISO 16826)*

EN ISO 16827, *Non-destructive testing - Ultrasonic testing - Characterization and sizing of discontinuities (ISO 16827)*

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

EN ISO 22232-2, *Non-destructive testing - Characterization and verification of ultrasonic test equipment - Part 2: Probes (ISO 22232-2)*

EN ISO 22232-3, *Non-destructive testing - Characterization and verification of ultrasonic test equipment - Part 3: Combined equipment (ISO 22232-3)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16811, EN 16827 and EN ISO 16826 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/

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

3.1
equivalent reference discontinuity echo size
indication to be recorded during the assessment phase of an ultrasonic test, usually expressed as an equivalent diameter of a flat-bottomed hole (FBH)

3.2
point-like discontinuity
discontinuity, the dimensions of which are smaller than or equal to the sound-beam width

Note 1 to entry: Dimensions in this document relate to length, width and/or dimension in through-wall direction.

3.3
extended discontinuity
discontinuity, the dimensions of which are larger than the sound-beam width

Note 1 to entry: Dimensions in this document relate to length, width and/or dimension in through-wall direction.

3.4
planar discontinuity
discontinuity having two measurable dimensions

3.5
volumetric discontinuity
discontinuity having three measurable dimensions

3.6
rim zone
1/3 of the through-wall thickness from the surface with a maximum of 30 mm

3.7
special rim zone
outer rim zone of the test object with special requirements

Note 1 to entry: Examples of special requirements are machined surfaces, higher stresses and sealing surfaces.

3.8
non-measurable dimension
dimension of a discontinuity that is smaller than the beam width, which depends on the probe size and the frequency used. Current state of the industry is < 3 mm

3.9
production welding
any welding carried out during manufacturing before final delivery to the purchaser

3.9.1
joint welding
production welding used to assemble components together to obtain an integral unit

3.9.2
finishing welding
production welding carried out in order to ensure the agreed quality of the casting

4 Requirements

4.1 Order information

The following information shall be available at the time of enquiry and order (see also ISO 16810):

a) the areas of the casting and the number or percentage of castings to which the requirements of ultrasonic testing apply;

b) the severity levels to be applied to the various zones or areas of the casting (acceptance criteria);

c) requirements for a written test procedure;

d) whether there are any additional requirements for the test procedure, see also 5.5.1.

4.2 Extent of testing

The casting shall be tested so that the agreed areas are covered (insofar as this is possible from the shape of the casting) by the use of the best applicable test technique.

For wall thicknesses greater than 600 mm, agreement shall be made between the manufacturer and the customer on the severity levels, test procedure and the recording of the test results.

4.3 Maximum acceptable size of discontinuities

4.3.1 General

The purchaser shall specify the acceptance level according to the required severity level for planar and volumetric discontinuities within each zone and in each specified area of the casting.

The wall section shall be divided into core and rim zones as shown in Figure 1. These sections relate to the sizes of castings ready for assembly (finish machined).

4.3.2 Indications without measurable dimensions

In special rim zones and at weld preparation ends, indications without measurable dimensions are limited to a maximum number of indications.

These indications shall not exceed the limits given in Table 1.

4.3.3 Indications with measurable dimensions

4.3.3.1 General

Single discontinuities extending into the rim zone and core zone shall be evaluated as rim zone.

4.3.3.2 Acceptance levels for planar discontinuities

Planar discontinuities shall not exceed the limits given in Figure 2.

Discontinuities exceeding 3 mm shall not be acceptable in severity level 1.

The largest dimension of a discontinuity in through-wall direction shall not exceed 10 % of the wall thickness, except discontinuities with a length ≤ 10 mm. Discontinuities with a length of ≤ 10 mm shall not exceed a dimension in the through-wall dimension of 25 % of the wall thickness or maximum 20 mm.

The greatest distance between discontinuities, as criterion for evaluation as an individual discontinuity or a discontinuity area in the through-wall direction or lateral to the surface, shall be 10 mm.

For a discontinuity with more than 3 mm in length and non-measurable dimension in through-wall direction, this non-measurable dimension shall be taken as 3 mm and the area shall be calculated as follows:

$$A = 3L \qquad (1)$$

where

A is the area of discontinuity expressed in square millimetres;

3 is the width in millimetres;

L is the length in millimetres.

The sizing of small planar discontinuities, as given in Figure 2, becomes more difficult with increasing beam-path length and sound-beam diameter. As a guide, these sizings are normally applied to a rim zone of 30 mm. It makes the use of probes with focussed beams such as dual- transducer probes necessary.

4.3.3.3 Acceptance levels for volumetric discontinuities

Volumetric discontinuities shall not exceed the sizes given in Figure 3 for rim zone and Figure 4 for the core zone.

Indications with measurable dimensions shall not be acceptable in severity level 1.

The maximum acceptable dimensions of discontinuity areas in the through-wall direction in the rim zone shall be 15 % of the rim zone thickness. The maximum acceptable dimensions of discontinuity areas in the through-wall direction in the core zone shall be 15 % of the wall thickness.

The maximum distance between discontinuities, as a criterion for evaluation as an individual indication in the through-wall direction or lateral to the surface, shall be 10 mm in the rim zone and 20 mm in the core zone.

Groups of individual discontinuities (reference code GIR, see Table 4) consist of individual areas, each containing a group of several, individually resolved indications. An area of grouped indications is treated as an individual area when its distance to the neighbouring area is bigger than the biggest lateral dimension of each area. An example is given in Figure D.6.

For a discontinuity with more than 3 mm in length and non-measurable dimension in the through-wall direction, this non-measurable dimension shall be taken as 3 mm and the area shall be calculated as follows:

$$A = 3L \tag{2}$$

where

A is the area of discontinuity, in square millimetres;

3 is the width taken, in millimetres;

L is the length, in millimetres.

Unless otherwise agreed at the time of enquiry and order, when conducting radiographic and ultrasonic testing in combination it was proven that if a discontinuity indicated by radiographic testing is situated in the core zone, the discontinuity is acceptable at one level lower, e.g. in severity level 3 instead of severity level 2 for radiographic testing. For further information, see EN 1559-2.

4.4 Qualification of personnel

Ultrasonic testing shall be performed by qualified personnel. Qualification of personnel may be in accordance with EN ISO 9712 or a certification scheme considered equivalent.

4.5 Wall section zones

The wall section shall be divided into core and rim zones as shown in Figure 1. These zones relate to the dimensions of the casting ready for assembly (finish-machined).

4.6 Severity levels

If the purchaser specifies different severity levels in different areas of the same casting, all of these areas shall be clearly identified and shall include:

a) all necessary dimensions for accurate location of zones;

b) the full extent of all weld preparations and the thickness of any special rim zone.

Severity level 1 is only applied to weld preparations and special rim zones.

Unless other requirements have been agreed at the time of acceptance of the order, for finishing welds, the requirements for the parent metal shall apply.

5 Testing

5.1 Principles

The principles of ultrasonic testing given in EN ISO 16810, EN ISO 16811 and EN ISO 16827 shall apply.

5.2 Material

The suitability of material for ultrasonic testing is assessed by comparison with the echo height of a reference reflector (usually the first back-wall echo) and the noise level. This assessment shall be carried out on selected casting areas which are representative of the surface finish and of the total thickness range of the objects to be tested. The assessment areas shall have parallel surfaces.

The reference echo height according to Table 2 shall be at least 6 dB above the noise level.

If the echo height of the smallest detectable flat-bottomed or equivalent side-drilled hole diameter at the far end of the test range to be assessed is less than 6 dB above the noise level, then ultrasonic testing has reduced performance. In this case, the diameter of the flat-bottomed or side-drilled hole which can be detected with a signal-to-noise ratio of at least 6 dB shall be noted in the test report and the additional procedure shall be agreed between the manufacturer and the purchaser.

NOTE For the definition of an adequate diameter of a flat-bottomed hole, the distance-gain-size system (DGS) or a test block of identical material, heat treatment and thickness containing flat-bottomed holes with a diameter according to Table 2 or equivalent side-drilled holes, can be used. Formula (3) can be used for converting a flat-bottomed hole diameter into an equivalent side-drilled hole diameter:

$$D_{\mathrm{Q}} = \frac{4,935\ D_{\mathrm{FBH}}^{4}}{\lambda^{2}\ s} \tag{3}$$

where

D_{Q} is the side-drilled hole diameter, in millimetres;

D_{FBH} is the flat-bottomed hole diameter, in millimetres;

λ is the wavelength, in millimetres;

s is the path length, in millimetres.

The formula is applicable for $D_{\mathrm{Q}} \geq 2\,\lambda$ and $s \geq 5$ times the near-field length and is only defined for single-transducer probes.

5.3 Equipment and coupling medium

5.3.1 Ultrasonic instrument

The ultrasonic instrument shall meet the requirements given in EN ISO 22232-1 and shall have the following characteristics:

a) range setting capability, from at least 10 mm to 2 m, continuously selectable, for longitudinal and transverse waves in steel;

b) gain span, adjustable in 2 dB maximum steps over a range of at least 80 dB with an accuracy of 1 dB;

c) inaccuracy of time-base and vertical linearities less than 5 % of the adjustment range of the screen;

d) operating in combined transmitter-receiver mode or in separate transmitter-receiver-mode;

e) suitability, at least for nominal frequencies from 1 MHz up to and including 6 MHz, for the pulse-echo technique with single-transducer and dual-transducer probes.

5.3.2 Probes

The probes shall meet the requirements given in EN ISO 22232-2 and EN ISO 22232-3 with the following exceptions:

a) nominal frequencies shall be in the range 1 MHz to 6 MHz;

b) for oblique incidence, angle-beam probes with angles between 35° and 70° shall be used.

NOTE Normal-beam or angle-beam probes can be used for the testing of steel castings for highly stressed components. The type of probe depends on the geometry of the casting and the type of discontinuity to be detected.

For test zones close to the surface, dual-transducer probes (normal-beam or angle-beam) should be preferred.

5.3.3 Checking of the ultrasonic test equipment

The ultrasonic test equipment shall be checked regularly by the operator according to EN ISO 22232-3.

5.3.4 Coupling medium

A coupling medium in accordance with EN ISO 16810 shall be used. The coupling medium shall wet the test surface to ensure satisfactory sound transmission. The same coupling medium shall be used for the setting and all subsequent test operations.

NOTE The sound transmission can be checked by one or more stable back-wall echoes in areas of the test object with parallel surfaces.

5.3.5 Test sensitivity and resolution of detection

The test sensitivity of the instrument shall allow at least the setting of the sensitivity in accordance with the requirements of 5.5.2.

The resolution of detection of the instrument-probe combination shall meet the requirements of Annex A.

5.4 Preparation of casting surfaces for testing

For the preparation of casting surfaces for ultrasonic testing, see EN ISO 16810.

The casting surfaces to be tested shall be such that satisfactory coupling with the probe can be achieved.

With single-transducer probes, satisfactory coupling can be achieved if the condition of the surfaces to be used for testing corresponds at least to the limit comparator 4 S1 or 4 S2 according to EN 1370.

The roughness of any machined surface used for testing shall be $R_a \leq 12{,}5$ µm.

For special test techniques, higher surface qualities such as 2 S1, 2 S2 (see EN 1370) and $R_a \leq 6{,}3$ µm can be necessary.