SLOVENSKI STANDARD
oSIST prEN 12680-3:2024

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Livarstvo - Ultrazvočno preskušanje - 3. del: Ulitki iz sive litine s kroglastim grafitom

Founding - Ultrasonic testing - Part 3: Spheroidal graphite cast iron castings

Gießereiwesen - Ultraschallprüfung - Teil 3: Gussstücke aus Gusseisen mit Kugelgraphit

Fonderie - Contrôle par ultrasons - Partie 3: Pièces moulées en fonte à graphite sphéroïdal

Ta slovenski standard je istoveten z: **prEN 12680-3**

ICS:

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

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EUROPEAN STANDARD

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DRAFT prEN 12680-3

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English Version

Founding - Ultrasonic testing - Part 3: Spheroidal graphite cast iron castings

Fonderie - Contrôle par ultrasons - Partie 3: Pièces moulées en fonte à graphite sphéroïdal

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

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

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European foreword

This document (prEN 12680-3:2023) 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 12680-3:2011.

In comparison with the previous edition, the following technical modifications have been made:

— see the detail of the changes in Annex A (Table A.1).

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

prEN 12680-1, Founding — Ultrasonic examination — Part 1: Steel castings for general purposes;

prEN 12680-2, Founding — Ultrasonic examination — Part 2: Steel castings for highly stressed

1 Scope

This document specifies the requirements for the ultrasonic testing of spheroidal graphite cast iron castings and the techniques for determining internal discontinuities by the pulse-echo technique.

This document does not apply to ultrasonic testing of the nodularity of spheroidal graphite cast irons.

This document does not apply to phased array technique and to transmission technique.

NOTE The transmission technique has insufficient sensitivity to detect the discontinuities found in spheroidal graphite cast iron castings and is used in exceptional cases only.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN ISO 5577, *Non-destructive testing - Ultrasonic testing - Vocabulary (ISO 5577)*

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

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)*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 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 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
1/5 of the through-wall thickness from the surface with a minimum of 5 mm and a maximum of 30 mm

3.7
non-measurable dimension
dimension of a discontinuity that is smaller than the beam width, which depends on the probe size and the frequency used

Note 1 to entry: Current state of the industry is < 3 mm.

3.8
dross
accumulation of fine slag particles (oxides, sulphides, etc.) in the rim zone of castings

Note 1 to entry: In smaller castings, dross is usually not detected by ultrasonic testing.

4 Requirements

4.1 Order information

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

— The areas of the casting and the number or percentage of castings to which the for ultrasonic testing apply.

— The severity levels for small castings in accordance with Table 1 and if applicable Table 3, or for large castings Table 2 and if applicable Table 4, to be applied to the various areas of the casting.

— Requirements for a written test procedure.

— The customer should inform the supplier about the required amount of machining.

— Whether there are any additional requirements.

NOTE 1 Severity levels in Tables 1 and 3 as well as in Tables 2 and 4 can be chosen differently.

NOTE 2 Small castings are typically produced under serial conditions, e.g. automatic moulding lines, with a mass up to 200 kg.

NOTE 3 Large castings are typically hand moulded, with a mass higher than 200 kg.

4.2 Extent of testing

The areas of the casting to be tested shall be agreed. This agreement shall state how these areas are to be tested, i.e. point testing or scanning, and in which directions.

These areas should be preferably indicated on the casting drawing.

For wall thicknesses outside of the range 10 mm to 500 mm, agreement shall be made between the parties concerned on the test procedure and also on the recording and acceptance levels.

4.3 Maximum acceptable size of discontinuities

Unless otherwise agreed between the parties concerned, the maximum acceptable sizes of discontinuities shall not exceed those of the severity level given in either Table 1 resp. 2 and/or Table 3 resp. 4.

4.4 Qualification of personnel

Ultrasonic testing shall be performed by qualified personnel. Qualification of personnel can 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. For wall thickness equal to or less than 10 mm the total wall thickness shall be considered as rim zone.

These zones relate to the dimensions of the casting ready for assembly (“finish machined”).

When a discontinuity is located simultaneously in both, the rim zone and the core zone, the following applies:

— If ≥ 20 % of rim zone thickness is affected, the discontinuity is to be considered as a rim zone discontinuity;

— If < 20 % of rim zone thickness is affected, the discontinuity is to be considered as a core zone discontinuity.

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.

5 Testing

5.1 Principles

The principles given in EN ISO 16810 and EN ISO 16811 shall apply.

5.2 Material

The suitability of a 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. The assessment areas shall have parallel surfaces.

The reference echo height shall be at least 6 dB above the noise level. If the echo height of this smallest detectable flat-bottomed or equivalent side-drilled hole diameter at the end of the test range to be assessed is less than 6 dB above the noise level, then the ultrasonic testability is reduced. In this case, the flat-bottomed or side-drilled hole diameter 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.

If a distance-gain-size diagram (DGS) is available, the suitability of castings for ultrasonic testing with normal-beam probes can be determined for example as follows: with the suppression switched off, the back-wall echo is brought to any reference level desired. The amplification according to the DGS diagram is then increased so that the echo signal height from the reference reflector according to 5.3.5.3 reaches the reference level. If the amplification is further increased by 6 dB the background noise level should not exceed the reference height. If necessary, a reference reflector can be used to determine the testing suitability in areas without the back-wall echo.

5.3 Test equipment and coupling fluid

5.3.1 Ultrasonic instrument

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

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

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

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

f) suitability at least for nominal frequencies from 0,5 MHz up to and including 5 MHz in pulse-echo technique with dual-element probe and single-element probe.

5.3.2 Probes and transducer frequencies

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

a) to cover the range of discontinuity types to be detected, the casting can be tested using compression-wave dual-element probe or single-element probe.

   Dual-element probe should be used for the testing of areas close to the test surface.

b) for special geometrical conditions, angle-beam probes can be used up to a sound path length of about 100 mm, preferably with nominal angles between 45° and 70°. The frequency value shall be selected to suit the test and shall be within the range 0,5 MHz to 5 MHz. Higher frequencies can be used for testing wall thicknesses of less than 20 mm or areas close to the surface.

For the detection of near-surface discontinuities, the use of dual-element and/or angle probes is recommended.

NOTE 1 Since sound travels at different velocities in steel and spheroidal graphite cast iron, the actual angle of refraction deviates from the nominal angle of the probe for steel.

If the sound velocity of spheroidal graphite cast iron is known, the angle of refraction of the probe can be determined from the sound velocity according to Figure 2.

Figure 3 shows how the angle of refraction can be determined to an accuracy sufficient for practical purposes using two probes of the same type. The sound velocity of spheroidal graphite cast iron can also be determined from the angle of refraction α as follows:

$$C_c = 3\,255 \times \frac{\sin \alpha_c}{\sin \alpha_s} \quad (1)$$

where

C_c is the sound velocity of transverse waves in the casting in metres per second;

3 255 is the sound velocity of transverse waves for steel in metres per second,

α_c is the angle of refraction in the casting in degrees;

α_s is the angle of refraction in steel in degrees.

NOTE 2 For special cases, longitudinal wave angle beam probes can be used.

NOTE 3 The longitudinal wave velocity for spheroidal graphite cast iron is equal to or above 5 500 m/s.

5.3.3 Checking the ultrasonic test equipment

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

5.3.4 Coupling fluid

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

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

5.3.5 Time base range and sensitivity setting of the ultrasonic test equipment

5.3.5.1 General

A spheroidal graphite cast iron reference block shall be used for range and sensitivity setting. The thickness of the reference block shall be comparable to the wall thickness range of the casting to be tested and shall be agreed at the time of enquiry and order. The reference block shall have the same ultrasonic properties as the casting to be tested and shall have the same surface finish. The reference block shall contain flat-bottomed holes according to Table 5 or equivalent side-drilled holes as reference reflectors.

NOTE The following equation is used for converting the flat-bottomed hole diameter into the side-drilled hole diameter:

$$D_Q = \frac{4,935 \times D_{FBH}^4}{\lambda^2 \times s} \quad (1)$$

where