SLOVENSKI STANDARD
SIST EN 12680-3:2003

01-november-2003

Livarstvo ï Ultrazvoļna preiskava ï 3. del: Ulitki iz sive litine s kroglastim grafitom

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

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

Fonderie - Contrôle par ultrasons - Partie 3: Pieces moulées en fonte a graphite sphéroidal

Ta slovenski standard je istoveten z: EN 12680-3:2003

ICS:

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

SIST EN 12680-3:2003 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12680-3

January 2003

ICS 77.040.20

English version

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

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

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

This European Standard was approved by CEN on 21 November 2002.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Foreword

This document (EN 12680-3:2003) has been prepared by Technical Committee CEN /TC 190 "Foundry Technology", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2003, and conflicting national standards shall be withdrawn at the latest by July 2003.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 4.10 "Inner defects" to prepare the following standard:

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

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

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

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the requirements for the ultrasonic examination of spheroidal graphite cast iron castings and the methods for determining internal discontinuities by the pulse-echo technique.

This European Standard does not deal with the ultrasonic examination of the nodularity of spheroidal graphite cast irons.

This European Standard does not cover the 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

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 583-1, *Non-destructive testing — Ultrasonic examination — Part 1: General principles.*

EN 583-2, *Non-destructive testing — Ultrasonic examination — Part 2: Sensitivity and range setting.*

EN 583-3, *Non-destructive testing — Ultrasonic examination — Part 3: Transmission technique.*

EN 583-5, *Non-destructive testing — Ultrasonic examination — Part 5: Characterization and sizing of discontinuities.*

EN 1330-4, *Non-destructive testing — Terminology — Part 4: Terms used in ultrasonic testing.*

EN 12223, *Non-destructive testing — Ultrasonic examination — Specification for calibration block No. 1.*

EN 12668-1, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 1: Instruments.*

EN 12668-2, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 2: Probes.*

EN 12668-3, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 3: Combined equipment.*

EN 27963, *Welds in steel — Calibration block No. 2 for ultrasonic examination of welds (ISO 7963:1985).*

NOTE Informative references to documents used in the preparation of this standard, and cited at the appropriate places in the text, are listed in the bibliography.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1330-4 apply.

4 Requirements

4.1 Order information

The following information shall be available at the time of enquiry and order (see also EN 583-1):

— the areas of the casting and the number or percentage of castings to which the ultrasonic examination requirements apply;

— the severity levels in accordance with Tables 1 and 2 to be applied to the various areas of the casting;

— requirements for a written examination procedure.

4.2 Extent of examination

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

NOTE 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 examination procedure and also on the recording and acceptance levels.

4.3 Maximum permissible size of discontinuities

Unless otherwise agreed between the parties concerned, the maximum permissible sizes of discontinuities shall not exceed those of the severity level given in either Table 1 (shrinkage) and/or Table 2 (dross).

4.4 Personnel qualification

It is assumed that ultrasonic examination is performed by qualified and capable personnel. In order to prove this qualification, it is recommended to certify personnel in accordance with EN 473.

4.5 Wall section zones

The wall section shall be divided into zones as shown in Figure 1.

NOTE These wall sections relate to the dimensions of the casting ready for assembly (finish machined).

5 Test method

5.1 Principles

The principles given in EN 583-1, EN 583-2 and EN 583-3 shall apply.

5.2 Material

The suitability of a material for ultrasonic examination is assessed by comparison with the echo height of a reference reflector (usually the first back wall echo) and the noise signal. 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 signal.

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 grass 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-noise ratio of at least 6 dB shall be noted in the examination report and the additional procedure shall be agreed between the manufacturer and the purchaser.

NOTE If a distance gain size diagram (DGS) is available, the suitability of castings for ultrasonic examination with normal probes can be determined for example as follows: with the suppression switched off, the backwall 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 substitute 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 backwall echo.

5.3 Equipment, coupling medium, calibration and sensitivity

5.3.1 Ultrasonic instrument

The ultrasonic instrument shall meet the requirements given in EN 12668-1 and shall have the following characteristics:

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

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

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

— suitability at least for nominal frequencies from 0,5 MHz up to and including 5 MHz in pulse-echo technique with single-crystal and twin-crystal probes.

5.3.2 Probes and transducer frequencies

The probes and transducer frequencies shall be as given in EN 12668-2 and EN 12668-3 with the following exceptions:

— to cover the range of discontinuity types to be detected, the casting can be examined using compression-wave single-crystal or twin-crystal probes.

NOTE 1 Twin-crystal probes should be used for the examination of areas close to the test surface.

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

NOTE 2 For the detection of near-surface discontinuities, the use of twin-crystal and/or angle probes is recommended.

NOTE 3 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:

$$C_C = 3\,255 \times \frac{\sin \alpha_C}{\sin \alpha_S} \qquad (1)$$

where

C_c the sound velocity in the casting 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 4 To simplify examination, special probes can be used, e.g. angle probes for longitudinal waves.

5.3.3 Checking the ultrasonic examination equipment

The ultrasonic examination equipment shall be checked regularly by the operator according to EN 12668-3.

5.3.4 Coupling medium

A coupling medium in accordance with EN 583-1 shall be used. The coupling medium shall wet the examination area to ensure satisfactory sound transmission. The same coupling medium shall be used for calibration and all subsequent examination operations.

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

5.3.5 Calibration of the ultrasonic equipment

5.3.5.1 General

A spheroidal graphite cast iron reference block shall be used for calibration. The thickness of the reference block shall be comparable to the wall thickness range of the casting to be examined 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 examined and shall have the same surface finish. The reference block shall contain flat-bottomed holes according to Table 3 or equivalent side-drilled holes as substitute reflectors.

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

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

where

D_Q is the side-drilled hole diameter in millimeter;

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

λ is the wave length in millimeter;

s is the path length in millimeter.

The formula is applicable for $D_Q \geq 2\,\lambda$ and $s \geq 5 \times$ nearfield length and is only defined for single element probes.

Other substitute reflector sizes or reflector types may be agreed at the time of enquiry and order. All sound of the reference block shall be flat and parallel. If standard steel calibration blocks are used, differences in sound velocity, sound attenuation and surface quality between the casting and the calibration blocks shall be taken into consider-ation.

The equipment can also be set using a DGS diagram [1] (see bibliography) calculated for spheroidal graphite cast iron. In this case, the reference block is not necessary and calibration can be done on the casting itself.