SLOVENSKI STANDARD
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Neporušitveno preskušanje jeklenih izkovkov - 4. del: Ultrazvočno preskušanje avstenitnih in avstenitno-feritnih nerjavnih jeklenih izkovkov

Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings

Zerstörungsfreie Prüfung von Schmiedestücken aus Stahl - Teil 4: Ultraschallprüfung von Schmiedestücken aus austenitischem und austenitisch-ferritischem nichtrostendem Stahl

Essais non destructifs des pièces forgées en acier - Partie 4 : Contrôle par ultrasons des pièces forgées en aciers inoxydables austénitiques et austéno-ferritiques

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77.140.85	Železni in jekleni kovani izdelki	Iron and steel forgings

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English Version

Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and ferritic-austenitic stainless steel forgings

Essais non destructifs des pièces forgées en acier - Partie 4: Contrôle par ultrasons des pièces forgées en aciers inoxydables austénitiques et austéno-ferritiques

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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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Foreword

This document (prEN 10228-4:2014) has been prepared by Technical Committee ECISS/TC 111 “Steel castings and forgings”, the secretariat of which is held by AFNOR.

This document is currently submitted to the COCOR Vote.

This document will supersede EN 10228-4:1999.

EN 10228 consists of the following parts under the general title "*Non-destructive testing of steel forgings*":

— *Part 1: Magnetic particle inspection*

— *Part 2 : Penetrant testing*

— *Part 3 : Ultrasonic testing of ferritic or martensitic steel forgings*

— *Part 4: Ultrasonic testing of austenitic and ferritic- austenitic stainless steel forgings.*

1 Scope

This Part of EN 10228 describes techniques for the manual, pulse-echo, ultrasonic testing of forgings manufactured from austenitic and ferritic-austenitic stainless steels. Mechanised scanning techniques, such as immersion testing, may be used but should be agreed between the purchaser and supplier (see clause 4).

This Part of EN 10228 applies to four types of forgings, classified according to their shape and method of production. Types 1, 2 and 3 are essentially simple shapes. Type 4 covers complex shapes.

This Part of EN 10228 does not apply to:

— closed die forgings;

— turbine rotor and generator forgings.

Ultrasonic testing of ferritic and martensitic steel forgings is the subject of Part 3 of this European Standard.

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 1330-1:1998 *Non-destructive testing - Terminology - Part 1: List of general terms*

EN 1330-4:2010, *Non-destructive testing - Terminology - Part 4: Terms used in ultrasonic testing*

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

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

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)*

3 Definitions

For the purpose of this document the terms and definitions given in EN 1330-1:1998 and EN 1330-4:2010 apply.

4 Mandatory information

The following aspects concerning ultrasonic testing shall be agreed between the purchaser and supplier at the time of the enquiry or order:

a) the manufacturing stage(s) at which ultrasonic testing shall be performed. (see clause 9)

b) the volume(s) to be tested and whether grid scanning coverage or 100 % scanning coverage is required (see clause 12);

c) whether near surface testing is required (see 7.2.6);

d) the quality class required, or the quality classes and the zones to which they apply (see clause 14);

e) the applicable recording/acceptance criteria if different from those detailed in Table 5, Table 6 or Table 7;

f) whether any special scanning coverage, equipment or couplant is required in addition to that detailed in clauses 7 and 12;

g) the scanning technique to be used if not manual (see clause 1);

h) the sizing techniques to be used for extended discontinuities (see clause 15);

i) the technique(s) to be used for setting sensitivity (see clause 11);

j) whether the test is to be conducted in the presence of the purchaser or his representative;

k) whether a written procedure shall be submitted for approval by the purchaser (see clause 5);

l) whether testing by angle-beam probes is required (see 11.3);

m) the remaining test requirements for complex forgings (type 4) (see 12.2).

5 Test procedure

5.1 General

Ultrasonic testing shall be performed in accordance with a written test procedure. Where specified in the enquiry or order, the written test procedure shall be submitted to the purchaser for approval prior to the test.

5.2 Form

The written test procedure shall be one of the following:

a) a product specification;

b) a test procedure written specifically for the application;

c) this Part of EN 10228 may be used if it is accompanied by examination details specific to the application.

5.3 Content

The written test procedure shall contain the following details as minimum requirements:

a) description of the forgings to be tested;

b) reference documents;

c) qualification and certification of testing operator;

d) stage of manufacture at which the test is carried out;

e) testing zones specified in terms of the applicable quality classes;

f) preparation of scanning surfaces;

g) couplant;

h) description of the test equipment;

i) calibration and checking of the test equipment;

j) scanning plan;

k) description and sequence of testing operations;

l) recording levels;

m) characterisation of discontinuities;

n) acceptance criteria;

o) test report.

6 Personnel qualification

Personnel shall be qualified and certificated in accordance with the requirements detailed in EN ISO 9712.

7 Equipment and accessories

7.1 Instrument

The ultrasonic instrument shall feature A-scan presentation and shall conform to EN 12668-1.

7.2 Probes

7.2.1 General

Probes used for the initial detection of discontinuities shall conform to EN 12668-2. Where supplementary probes are used for purposes other than the initial detection of discontinuities, they need not conform to EN 12668-2.

7.2.2 Contouring

When required, probes shall be contoured in accordance with EN ISO 16811.

7.2.3 Nominal frequency

Probes shall have a nominal frequency in the range from 0,5 MHz to 6 MHz.

7.2.4 Normal-beam probes

Effective transducer diameter shall be in the range from 10 mm to 40 mm.

7.2.5 Angle-beam probes

Beam angles of angle-beam probes shall be in the range from 35° to 70°.

Effective transducer area shall be in the range from 20 mm² to 625 mm².

7.2.6 Dual-element probes

If near-surface testing is required, then dual-element probes shall be used.

7.3 Calibration blocks

Calibration blocks shall conform to the requirements detailed in EN ISO 2400.

7.4 Reference blocks

Reference blocks shall be used when sensitivity is to be established by the distance amplitude curve (DAC) technique and/or when discontinuities are to be sized in terms of amplitude relative to reference reflectors by the DAC technique. The surface condition of the reference block shall be representative of the surface condition of the object to be tested. Unless otherwise specified the reference block shall contain at least three reflectors covering the entire depth range being tested.

The reference block shall be manufactured from one of the following:

a) an excess length of the object to be tested

b) a part of the same material and with the same heat treatment condition as the object to be tested;

c) a part having similar acoustic properties to the object to be tested.

NOTE 1 The choice of a test block with similar acoustic properties should be to the appreciation of a Level 2 qualified person.

Reference blocks shall not be used for the distance gain size (DGS) technique other than for checking the accuracy of a particular DGS diagram.

NOTE 2 Reflector sizes different from those detailed in Tables 5 and 6 may be used as long as the test sensitivity is corrected accordingly.

7.5 Couplant

The same type of couplant shall be used for the setting of range and sensitivity, for scanning and for the assessment of discontinuities.

NOTE Examples of suitable couplants are: water (with or without corrosion inhibitor or softener), grease, oil, glycerol and water cellulose paste.

After the test, couplant shall be removed if its presence could adversely affect later manufacturing or testing operations or the integrity of the test object.

8 Routine calibration and checking

The combined equipment (instrument and probes) shall be calibrated and checked in accordance with the requirements detailed in EN 12668-3.

9 Stage of manufacture

Ultrasonic testing shall be performed after the final heat treatment unless otherwise agreed at the time of enquiry or order (see clause 4), e.g. at the latest possible stage of manufacture for areas of the forging which are not practicable to test after the final heat treatment.

NOTE For both cylindrical and rectangular forgings, which are to be bored, it is recommended to carry out ultrasonic testing before boring.

10 Surface condition

10.1 General

Surfaces to be scanned shall be free from paint, non-adhering scale, dry couplant, surface irregularities or any other substance which could reduce coupling efficiency, hinder the free movement of the probe or cause errors in interpretation.

10.2 Surface finish related to quality class

In the machined condition, for testing to quality classes 1 and 2, a surface finish corresponding to a roughness Ra ≤ 12,5 µm shall be produced and for testing of quality class 3, a surface finish corresponding to a roughness Ra ≤ 6,3 µm shall be produced.

Table 1 — Surface finish related to quality class [a]

Surface finish	Quality class and roughness R_a		
	1	2	3
	≤ 12,5 µm	≤ 12,5 µm	≤ 6,3 µm
Machined	X	X	X

[a] "X" signifies the quality class that can be achieved in machined conditions

10.3 As-forged surface condition

Where forgings are supplied in the as-forged surface condition they shall be considered acceptable providing the specified quality class can be achieved. When it is not practical to perform a comprehensive test on as-forged surfaces, shot blasting, sand blasting or surface grinding shall be used to ensure that acoustic coupling can be maintained.

NOTE Only quality class 1 is normally applicable.

11 Test sensitivity

11.1 General

Test sensitivity shall be sufficient to ensure the detection of the smallest discontinuities required by the recording levels (see Table 5 and when required, Tables 6 or 7). If the required sensitivity cannot be achieved due to coarse grain size, acceptance of the forging shall be subject to agreement between the purchaser and supplier.

11.2 Normal-beam probes

For normal-beam probes one of the following techniques shall be used to establish the sensitivity for scanning:

a) Distance amplitude curve (DAC) technique, based upon the use of side-drilled holes (flat-bottomed holes possible);

b) Distance gain size (DGS) technique (disc-shaped reflectors).

The procedure to be used in each case shall be in accordance with EN ISO 16811.

11.3 Angle-beam probes

For angle-beam probes one of the following techniques shall be used to establish the sensitivity for scanning:

a) DAC technique using 3 mm diameter side-drilled holes;

b) DGS technique (disc-shaped reflectors).

The procedure to be used in each case shall be as detailed in EN ISO 16811.

The DAC and DGS techniques shall not be compared for angle-beam probes.

11.4 Repeat testing

Where repeat testing is performed the same method of establishing sensitivity (DAC or DGS) shall be used as was initially used.

12 Scanning

12.1 General

Scanning shall be performed using the manual contact pulse-echo technique.

The minimum scanning coverage required is dictated by the type of forging and whether grid scanning coverage or 100 % scanning coverage has been specified in the enquiry or order (see clause 4).

Table 2 classifies four types of forging according to their shapes and method of production.

Table 3 specifies the requirements for normal-beam probes for forging types 1, 2 and 3.

Table 4 specifies the requirements for angle-beam probes for forging types 3a, 3b and 3c which have an outside diameter: inside diameter ratio less than 1,6:1. The effective depth of circumferentially oriented angle beam scans is limited by the beam angle and the forging diameter (see Annex A).