
Neporušitveno preskušanje jeklenih izkovkov - 3. del: Ultrazvočno preskušanje feritnih ali martenzitnih jeklenih izkovkov

Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings

Zerstörungsfreie Prüfung von Schmiedestücken aus Stahl - Teil 3: Ultraschallprüfung von Schmiedestücken aus ferritischem oder martensitischem Stahl

Essais non destructifs des pièces forgées en acier - Partie 3: Contrôle par ultrasons des pièces forgées en aciers ferritiques et martensitiques

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Teil 3: Ultraschallprüfung von Schmiedestücken aus
ferritischem oder martensitischem Stahl

This European Standard was approved by CEN on 21 December 1997.

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 Central Secretariat 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 Central Secretariat 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, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 28 "Steel forgings", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by November 1998, and conflicting national standards shall be withdrawn at the latest by November 1998.

The titles of the other Parts of this European Standard are:

- Part 1: Magnetic particle inspection
- Part 2: Penetrant testing
- Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings

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, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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1 Scope

This Part of EN 10228 describes the techniques to be used for the manual, pulse-echo, ultrasonic testing of forgings manufactured from ferritic and martensitic steel. 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 austenitic and austenitic-ferritic stainless steel forgings is the subject of Part 4 of this European Standard.

2 Normative references

This Part of EN 10228 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 Part of EN 10228 only when incorporated in by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 473	Qualification and certification of NDT personnel.
prEN 12668	Non-destructive testing - Characterization and verification of ultrasonic examination equipment. Part 1 : Instruments Part 2 : Probes Part 3 : Combined equipment
prEN 583	Ultrasonic examination Part 2 : Sensitivity and range setting. Part 5 : Characteristics and sizing of discontinuities.
prEN 12223	Ultrasonic examination - Calibration blocks
prEN 1330	Non-destructive testing - Terminology. Part 4 : Terms used in ultrasonic testing.

3 Definitions

For the purposes of this Part of EN 10228 the definitions given in prEN 1330-4 apply.

4 Items for agreement

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

- the manufacturing stage(s) at which ultrasonic testing shall be performed. (see clause 9);
- A the volume(s) to be tested and whether grid scanning coverage or 100 % scanning coverage is required. (see clause 12);
- B the use of twin crystal probes for near surface examination. (see 7.2.6);
- C the quality class required, or the quality classes and the zones to which they apply. (see clause 14);
- D the applicable recording/acceptance criteria if different from those detailed in table 5, table 6 or table 7;
- E whether any special scanning coverage, equipment or couplant is required in addition to that detailed in clauses 7 and 12;
- F the scanning technique to be used if not manual. (see clause 1);
- G the sizing techniques to be used for extended discontinuities (see clause 15);
- H the technique(s) to be used for setting sensitivity (see clause 11);
- I whether the test is to be conducted in the presence of the purchaser or his representative;
- J whether a written procedure shall be submitted for approval by the purchaser. (see clause 5).

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5 Written procedure

5.1 General

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

5.2 Form

This written procedure shall be in the form of:

- a product specification; or
- A a procedure written specifically for the application; or
- B this Part of EN 10228 - if it is accompanied by examination details specific to the application.

5.3 Content

The written procedure shall contain the following details as a minimum requirement:

- description of the forgings to be examined;
- A reference documents;
- B qualification and certification of examination personnel;
- C stage of manufacture at which the examination is carried out;
- D examination zones specified in terms of the applicable quality classes;
- E preparation of scanning surfaces;
- F couplant;

G	description of examination equipment;
H	calibration and settings;
I	scanning plan;
J	description and sequence of examination operations;
K	recording/evaluation levels;
L	characterisation of discontinuities;
M	acceptance criteria;
N	examination report.

6 Personnel qualification

Personnel shall be qualified and certificated in accordance with EN 473.

7 Equipment and accessories

7.1 Flaw detector

The flaw detector shall feature A-Scan presentation and conform to prEN 12668-1.

7.2 Probes

7.2.1 General requirements

Normal probes and shear wave probes shall conform to the requirements of prEN 12668-2.

Where further information is required supplementary probes may also be used. Supplementary probes shall not be used for the initial detection of defects. It is recommended that supplementary probes conform to prEN 12668-2.

7.2.2 Contouring

Probes shall be contoured when required by EN 583-2.

7.2.3 Nominal frequency

Probes shall have a nominal frequency in the range from 1 MHz to 6 MHz.

7.2.4 Normal probes

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

7.2.5 Shear wave probes

Shear wave probe beam angles shall be in the range from 35° to 70°.

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

7.2.6 Twin crystal probes

If near-surface examination is required, (see clause 4) then twin crystal probes shall be used.

7.3 Calibration blocks

Calibration blocks shall conform to prEN 12223.

7.4 Reference blocks

Reference blocks shall be made available when sensitivity is to be established by the distance amplitude curve (DAC) technique and/or when defects 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 part to be examined. Unless otherwise specified the reference block shall contain at least three reflectors covering the entire depth range under examination.

The form of the reference block will depend upon the application. It shall be manufactured from one of the following:

- an excess length of the part to be examined; or
- A a part of the same material and with the same heat treatment condition as the part to be examined; or
- B a part having similar acoustic properties to the part to be examined.

Reference blocks shall not be used for the distance gain size (DGS) technique unless it is required to check the accuracy of a particular DGS diagram.

NOTE: The sizes of reflectors in the reference block are governed by the sizes detailed in tables 5 and 6 as appropriate. Different sizes of reflectors from those detailed in tables 5 and 6 may be used provided the test sensitivity is corrected accordingly.

7.5 Couplant

The couplant used shall be appropriate to the application. The same type of couplant shall be used for calibration, setting sensitivity, scanning and defect assessment.

After completion of the examination, the couplant shall be removed if its presence could adversely affect later manufacturing or inspection operations or the integrity of the component.

NOTE: Examples of suitable couplants are:

water (with or without corrosion inhibitor or softener), grease, oil, glycerol and water cellulose paste.

8 Routine calibration and checking

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

9 Stage of manufacture

Ultrasonic testing shall be performed after the final quality 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 examine after the final quality 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

Scanning surfaces 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

The surface finish shall be compatible with the required quality class, (see table 1).

Table 1: Surface finish related to quality class

Surface finish	Quality class and roughness R_a			
	1	2	3	4
	$\leq 25 \mu\text{m}$	$\leq 12,5 \mu\text{m}$	$\leq 12,5 \mu\text{m}$	$\leq 6,3 \mu\text{m}$
Machined	X	X	X	X
Machined and heat treated	X	X	X	-

NOTE: X signifies the quality class that can be achieved for the specified surface finish.

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.

NOTE: It is difficult to carry out a comprehensive examination on as-forged surfaces. Shot blasting, sand blasting or surface grinding is recommended to ensure that acoustic coupling can be maintained. Normally only quality class 1 is applicable.

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11 Sensitivity

11.1 General

Sensitivity shall be sufficient to ensure the detection of the smallest discontinuities required by the recording/evaluation levels for the particular quality class specified. (see tables 5, 6 and 7).

One of the techniques detailed in 11.2 and 11.3 (DAC or DGS) shall be used to establish sensitivity for scanning with a particular probe. (see clause 4). The procedure to be used in each case shall be in accordance with prEN 583-2.

11.2 Normal probes

Distance amplitude curve (DAC) technique based upon the use of flat-bottomed holes;

A Distance gain size (DGS) technique.

11.3 Shear Wave probes

DAC technique using 3mm diameter side-drilled holes;

A DGS technique.

The DAC and DGS techniques shall not be compared for shear wave probes.

11.4 Repeat inspection

Where repeat inspection is performed, the same technique for 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 scanning coverage for forging types 1, 2 and 3.

Table 4 specifies the requirements for shear wave scanning coverage for forging types 3a and 3b which have outside diameter: inside diameter ratio less than 1,6:1. The effective depth of circumferentially oriented shear wave scans is limited by the probe angle and the forging diameter (see annex A).

12.2 Complex forgings

For complex shaped forgings or complex shaped parts of forgings (type 4) and small diameter forgings, the scanning coverage shall be agreed between the purchaser and the supplier at the time of enquiry and order (see clause 4). This shall include, at least, the required probe angles, scanning directions and extent of scanning coverage (grid or 100 %).

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12.3 Grid scanning coverage

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Grid scanning shall be performed with the probe or probes traversed along the grid lines defined in tables 3 and 4.

Where recordable indications are revealed by grid scanning, additional scanning shall be performed around the indications to determine their extent.

12.4 100 % scanning coverage

100 % scanning coverage shall be performed over the surfaces specified in tables 3 and 4, by overlapping consecutive probe traverses by at least 10 % of the effective probe diameter.

12.5 Scanning speed

Manual scanning speed shall not exceed 150 mm/s.