BRITISH STANDARD

BS EN
10228-3:1998

Non-destructive testing of steel forgings —

Part 3: Ultrasonic testing of ferritic or martensitic steel forgings

The European Standard EN 10228-3:1998 has the status of a British Standard

National foreword

This British Standard is the English language version of EN 10228-3:1998. Together with BS EN 10228-4 it supersedes BS 4124:1991 which will be withdrawn when BS EN 10228-4, *Ultrasonic testing of austenitic-ferritic stainless steel forgings*, is published.

The UK participation in its preparation was entrusted by Technical Committee ISE/73, Steels for pressure purposes, to Subcommittee ISE/73/3, Steel forgings for pressure purposes, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 15 and a back cover.

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EUROPEAN STANDARD

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Descriptors: Forgings, steels, non-destructive tests, ferritic steels, martensitic steels, ultrasonic tests, surface condition, inspection, acceptability, quality classes

English version

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

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

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

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

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.

Contents

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

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

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

prEN 583-2, *Ultrasonic examination — Part 2: Sensitivity and range setting.*

prEN 583-5, *Ultrasonic examination — 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:

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) the use of twin crystal probes for near surface examination (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**).

5 Written procedure

5.1 General

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) a product specification;

b) a procedure written specifically for the application; or

c) 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:

a) description of the forgings to be examined;

b) reference documents;

c) qualification and certification of examination personnel;

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

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

f) preparation of scanning surfaces;

g) couplant;

h) description of examination equipment;

i) calibration and settings;

j) scanning plan;

k) description and sequence of examination operations;

l) recording/evaluation levels;

m) characterization of discontinuities;

n) acceptance criteria;

o) 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 mm^2 to 625 mm^2.

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:

a) an excess length of the part to be examined; or

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

c) 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
	≤25 μm	≤12,5 μm	≤12,5 μm	≤6,3 μm
Machined	×	×	×	×
Machined and heat treated	×	×	×	—
NOTE × 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.

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

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

b) Distance gain size (DGS) technique.

11.3 Shear wave probes

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

b) 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 %).

12.3 Grid scanning coverage

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.

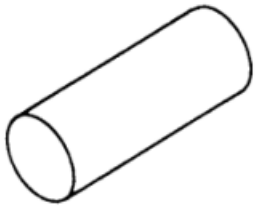
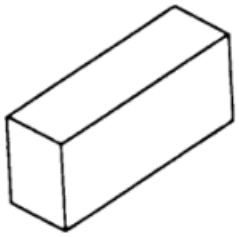
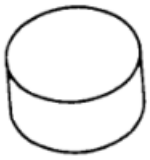
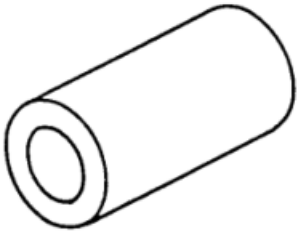
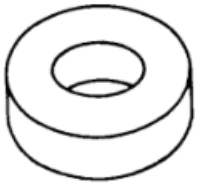
12.4 100 % scanning coverage

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.

Table 2 — Classification of forgings according to their shape and method of production

Type	Shape	Usual method of production[1)]
1a[2)]	Elongated with round or approximately round section, e.g. bars, rods, cylinders, shafts, journals, discs cut from bars 	Direct forged.
1b[2)]	Elongated with rectangular or approximately rectangular section, e.g. bars, rods, blocks, sections cut from bars 	
2[3)4)]	Flattened, e.g.: discs, plate, flywheels 	Upset
3a	Hollow cylindrical shapes, e.g.: bottles, compressed gas tanks 	Mandrel forged
3b	Hollow cylindrical shapes, e.g.: rings, flanges, rims 	Expanded
3c		
4	All forgings or parts of forgings with complex shape	Various

Notes:

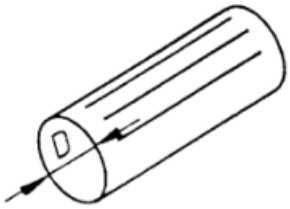
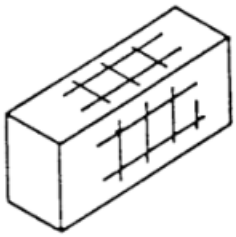
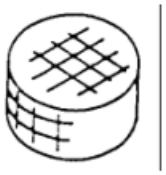
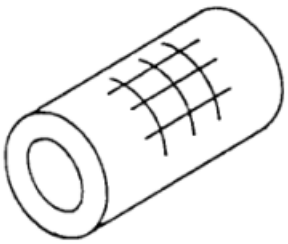
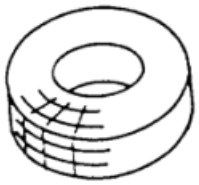
[1)] The purchaser shall be informed of the method of production at the time of enquiry and order.

[2)] Type 1 forgings may incorporate bores of small diameter relative to the major dimensions.

[3)] Type 2 forgings may eventually be drilled (e.g.: binding discs).

[4)] Type 2 forgings include products manufactured from forged billets and bars.

Table 3 — Scanning coverage with normal probes

<table>
<tr><th>Type</th><th colspan="3">Grid Scanning[1)]</th><th>100 % scanning[1)2)]</th></tr>
<tr><td rowspan="2">1</td><td>1a
  </td><td>Diameter, D
mm
$D \leq 200$
$200 < D \leq 500$
$500 < D \leq 1000$
$1000 < D$</td><td>Scan lines[3)]
2 at 90°
3 at 60°
4 at 45°
6 at 30°</td><td>Scan 100 % around at least 180° of cylindrical surface</td></tr>
<tr><td>1b
  </td><td colspan="2">Scan along the lines of a square-link grid on two perpendicular surfaces[3)4)]</td><td>Scan 100 % on two perpendicular surfaces</td></tr>
<tr><td>2</td><td>  </td><td colspan="2">Scan along the lines of a square-link grid around 360° on the cylindrical surface and one lateral surface[4)]</td><td>Scan 100 % around at least 180° on the cylindrical surface and 100 % of one lateral surface</td></tr>
<tr><td rowspan="2">3</td><td>3a
  </td><td colspan="2">Scan along the lines of a square-link grid around 360° on the outer cylindrical surface[4)]</td><td>Scan 100 % around 360° on the outer cylindrical surface</td></tr>
<tr><td>3b and 3c
  </td><td colspan="2">Scan along the lines of a square-link grid around 360° on the outer cylindrical surface and one lateral surface[4)]</td><td>Scan 100 % around 360° on the outer cylindrical surface and one lateral surface</td></tr>
<tr><td>4</td><td colspan="4">Scanning coverage shall be specified in the enquiry or order</td></tr>
</table>

Notes:

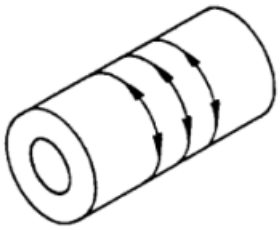
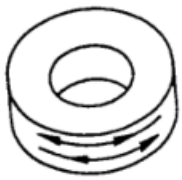
1) Additional scanning (for example in both axial directions for type 3a) may be carried out if specified in the enquiry or order.

2) 100 % means at least 10 % probe overlap between consecutive probe traverses.

3) For types 1a or 1b, if the presence of a bore prevents the opposite surface being reached, the number of scan lines shall be doubled symmetrically.

4) The grid line separation shall be equal to the part thickness up to a maximum of 200 mm.

Table 4 — Scanning coverage with shear wave probes

Type	Grid scanning[1)]		100 % scanning[1)2)]
3	3a 	Scan in both directions along 360° circumferential grid lines, the separation of which is equal to the radial thickness up to a maximum of 200 mm	Scan in both circumferential directions over 100 % on the outer cylindrical surface
	3b 		
4	Scanning coverage shall be specified in the enquiry or order		

Notes

[1)] Additional scanning coverage may be carried out if specified in the enquiry or order.

[2)] 100 % means at least 10 % probe overlap between consecutive probe traverses.

13 Classification

13.1 Classification of indications

Indications shall be classified according to their echodynamic patterns.

a) Pattern 1

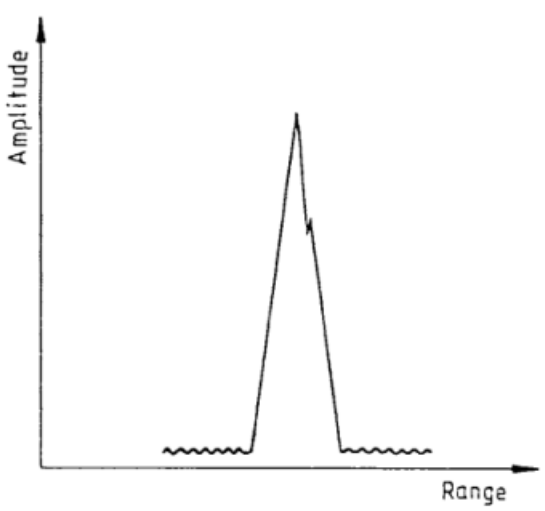
As the probe is moved, the A-scan display shows a single sharp indication rising smoothly in amplitude to a maximum and then falling smoothly to zero (see Figure 1).

This pattern corresponds to discontinuity dimensions smaller than or equal to the −6 dB beam profile, such as the echodynamic pattern obtained from the side-drilled holes used to plot the beam profile.

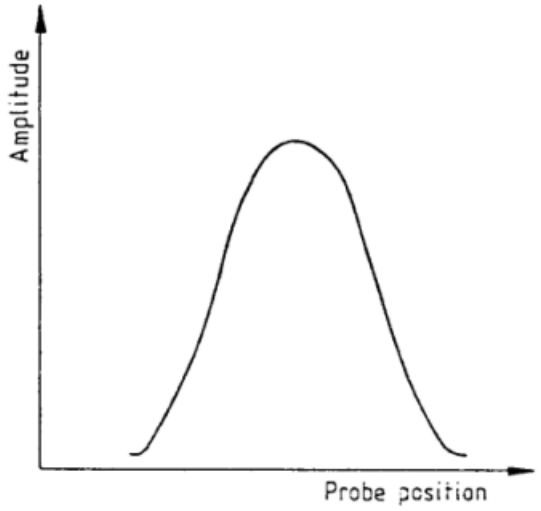
b) Pattern 2

As the probe is moved, the A-scan display shows a single sharp indication rising smoothly in amplitude to a maximum which is maintained with or without amplitude variation, and then falling smoothly to zero (see Figure 2).

This pattern corresponds to discontinuity dimensions greater than the −6 dB beam profile.

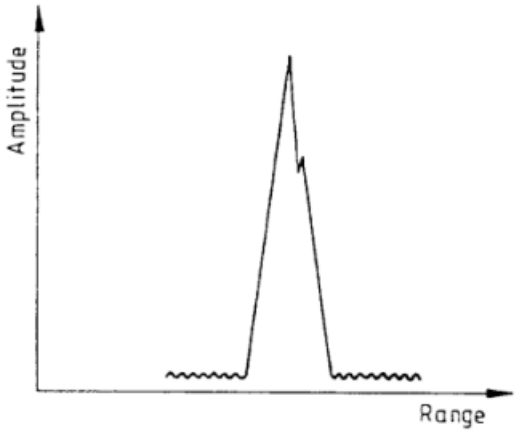


A-scan presentation
(At typical probe position)

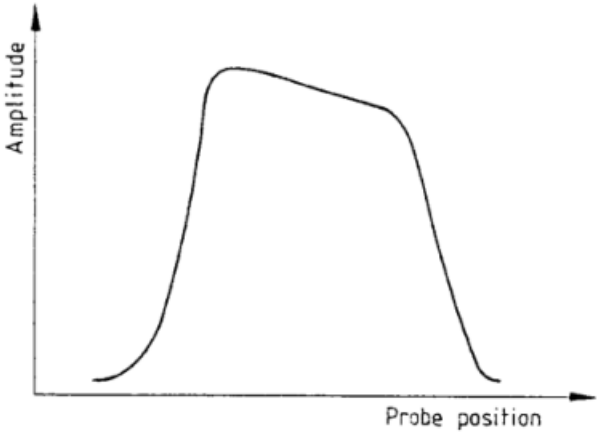


Echodynamic pattern
(Variation in signal amplitude as probe is moved)

Figure 1 — Pattern 1 A-scan presentation and echo envelope presentation



A-scan presentation
(At typical probe position)



Echodynamic pattern
(Variation in signal amplitude as probe is moved)

Figure 2 — Pattern 2 A-scan presentation and echo envelope presentation

13.2 Classification of discontinuities

Discontinuities shall be classified according to their echodynamic patterns as follows.

a) Point discontinuity

Echodynamic pattern 1 and/or dimensions equal to or less than the −6 dB beam width (see Figure 3).

b) Extended discontinuity

Echodynamic pattern 2 and/or dimensions greater than the −6 dB beam width (see Figure 4).

c) Isolated discontinuities

The distance d, between points corresponding to the maxima of the indications of adjacent discontinuities exceeds 40 mm (see Figure 5).

d) Grouped discontinuities

The distance d, between points corresponding to the maxima of the indications of adjacent discontinuities is less than or equal to 40 mm (see Figure 6).

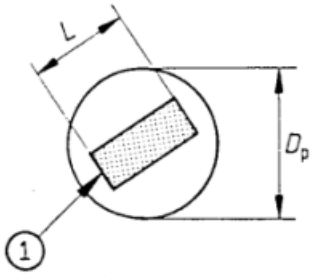


Figure 3 — Point discontinuity
($L > D_p$)

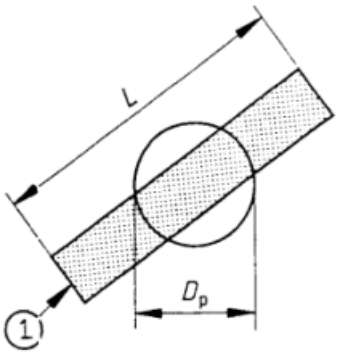


Figure 4 — Extended discontinuity
($L \leq D_p$)

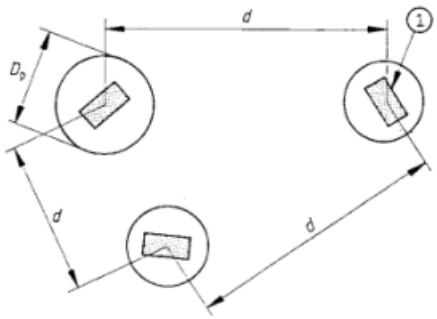


Figure 5 — Isolated point discontinuities
($L \leq D_p$, $d > 40$ mm)

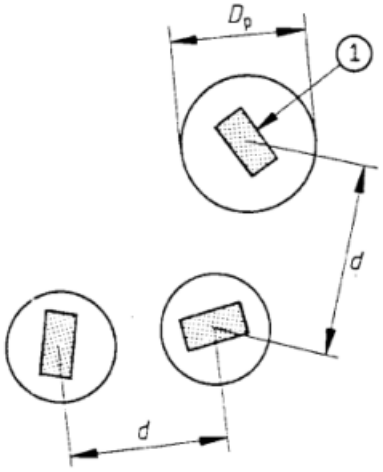


Figure 6 — Grouped point discontinuities
($L \leq D_p$, $d \leq 40$ mm)

Symbols used:

1:	Conventional outline of −6 dB discontinuity
D_p:	Width of beam at depth of discontinuity
d:	Distance between two discontinuities
L:	Conventional length of −6 dB discontinuity

14 Recording levels and acceptance criteria

The applicable quality class(es) shall be agreed between the purchaser and supplier (see clause **4**). Tables 5, 6 and 7 detail recording levels and acceptance criteria which shall be applied to four quality classes.

NOTE Several quality classes may be applied to a forging or to parts of a forging; quality class 4 is the most stringent, dictating the smallest recording levels and acceptance criteria. Where agreed, recording/evaluation levels and acceptance criteria different from those detailed in Tables 5, 6 and 7 may be used.

Table 5 — Quality classes, recording level and acceptance criteria for normal probes

Parameter	Quality class			
	1	2	3	4
Recording level				
Equivalent flat bottomed holes (EFBH) d_{eq} mm[1)]	> 8	> 5	> 3	> 2
Ratio R for rapid backwall echo reduction[2)3)]	≤ 0,1	≤ 0,3	≤ 0,5	≤ 0,6
Acceptance criteria				
EFBH (isolated point type discontinuities) d_{eq} mm[1)]	≤ 12	≤ 8	≤ 5	≤ 3
EFBH (extended or grouped point type discontinuities) d_{eq} mm[1)]	≤ 8	≤ 5	≤ 3	≤ 2

1) d_{eq} = Diameter of equivalent flat bottomed hole.

2) $R = \frac{F_n}{F_{o,n}}$

where:

n = 1 for $t \geq 60$ mm

n = 2 for $t < 60$ mm

F_n = amplitude (screen height) of the n^{th} reduced backwall echo

$F_{o,n}$ = amplitude (screen height) of the n^{th} backwall echo in the nearest discontinuity-free area at the same range as F_n.

3) If the reduction in backwall echo exceeds the recording level, this shall be further investigated.
Ratio R applies only to rapid reduction of backwall echo caused by the presence of a discontinuity.

Table 6 — Quality classes, recording level and acceptance criteria for shear wave probes using DGS techniques with flat bottomed holes

Quality class	1[1)]	2	3	4
Recording level d_{eq} mm[2)]	—	> 5	> 3	> 2
Acceptance criteria for isolated discontinuities d_{eq} mm[2)]	—	≤ 8	≤ 5	≤ 3
Acceptance criteria for extended or grouped point type discontinuities d_{eq} mm[1)]	—	≤ 5	≤ 3	≤ 2

Notes:

1) Shear wave scanning does not apply to quality class 1.

2) d_{eq} = Diameter of equivalent flat bottomed hole.

Table 7 — Quality classes, recording level and acceptance criteria for shear wave probes using DAC technique[1)]

Quality class	Nominal test frequency[3)] MHz	Recording level % (DAC)	Acceptance criteria	
			Isolated discontinuities[1)4)] % (DAC)	Extended or grouped point type discontinuities[1)4)] % (DAC)
1	[2)]			
2	1	50	100	50
	2	100	200	100
3	2	50	100	50
	4	100	200	100
4	2	30	60	30
	4	50	100	50

[1)] Based on 3 mm diameter side-drilled holes.

[2)] Shear wave scanning does not apply to quality class 1.

[3)] A DAC based on 3 mm diameter side-drilled holes shall be constructed for each frequency and each probe.

[4)] The indication amplitude in dB relative to the DAC is given in annex B.

15 Sizing

Where the extent of a discontinuity is required to be evaluated, one or more of the following techniques, as agreed between the purchaser and the supplier, shall be used. These techniques shall be carried out in accordance with the requirements detailed in prEN 583-5.

a) 6 dB-drop technique;

b) 20 dB-drop technique;

c) maximum amplitude technique.

16 Reporting

All tests shall be the subject of a written report which shall include the following information as a minimum requirement:

a) name of supplier;

b) order number;

c) identification of forging(s) under examination;

d) scope of examination: examination zones and applicable quality classes;

e) stage of manufacture at which ultrasonic testing was performed;

f) surface condition;

g) equipment used (flaw detector, probes, calibration and reference blocks);

h) technique(s) used to set sensitivity;

i) reference to this standard or reference to the written procedure used (where applicable);

j) results of examination:

k) location, classification and amplitude (in terms of FBH-equivalent diameter, or in percent of SDH) of all discontinuities exceeding the appropriate recording/acceptance criteria;

l) details of any restrictions to the required scanning coverage and if applicable the extent of the near surface zone;

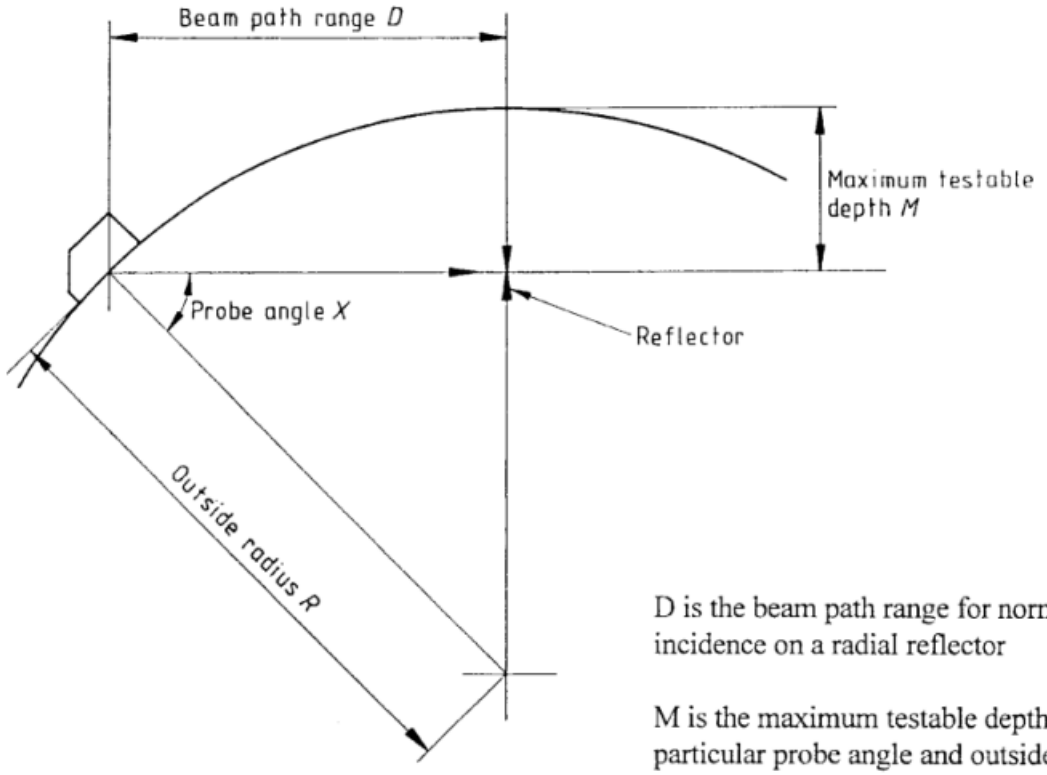
m) date of examination;

n) name, qualification and signature of operator.

Annex A (informative)

Maximum testable depth for circumferential shear wave scans

Figure A.1 shows the maximum testable depth for circumferential shear wave scans for a given probe and beam path range.



Probe angle *X*	Maximum test depth *M*	Beam path range *D*
70°	0.06*R*	0.34*R*
60°	0.13*R*	0.50*R*
50°	0.24*R*	0.64*R*
45°	0.30*R*	0.70*R*
35°	0.42*R*	0.82*R*

NOTE The maximum testable depth and beam path range to maximum testable depth are given in terms of the outside radius, *R*, of the forging for radial reflectors. The beam path range, *D*, values shown can effectively be doubled.

Figure A.1 — Maximum testable depth for circumferential shear wave scans

Annex B (informative)

dB amplitude of indication relative to % DAC

As an alternative to constructing a DAC which is a percentage of the 3 mm diameter side-drilled hole DAC (100 % DAC), the required recording/acceptance level may be achieved by constructing the 3 mm DAC (100 % DAC) and adjusting the amplitude according to Table B.1.

Table B.1 — dB amplitude relative to % DAC

DAC %	**Amplitude of indication relative to DAC** dB
30	−10
50	−6
60	−4
100	0
200	+ 6

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