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English version

英文版本

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

钢锻件的非破坏性试验 - 第 3 部分: 铁素体或马氏体钢锻件的超声波试验

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

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Foreword

前言

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

本欧洲标准已经由 ECISS/TC28 钢锻件技术委员会制备，其书记处在 BSL。

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of an identical text or by endorsement, at the latest by November 1998, and conflicting national standards shall be withdrawn at the latest by November 1998.

欧洲标准应给出国家标准的资质，不管通过出版等文本或者通过背书，最迟在 1998 年 11 月，有抵触的国家标准应该在 1998 年 11 月撤消。

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

本欧洲标准其他部分的题目包括：

— *Part 1: Magnetic particle inspection.*

— *Part 2: Penetrant testing.*

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

- 第 1 部分：磁粉探伤
- 第 2 部分：渗透剂试验
- 第 4 部分：奥氏体和奥氏体-铁素体不锈钢锻件的超声波测试

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按照 CEN/CENELEC 内部规定，下列国家标准组织必须执行本欧洲标准奥地利，比利时，捷克共和国，丹麦，芬兰，德国，希腊，芬兰，爱尔兰，意大利，卢森堡，荷兰，挪威，葡萄牙，西班牙，瑞典，瑞士和英国。

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1 Scope

1. 范围

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).

EN 10228-3 的本章节，描述了手册采用的脉冲反射式，由铁素体和马氏体钢制造的锻造件的超声波试验技术。可以使用机械扫描技术，如液浸试验，但是买方与供应商之间应该达成协议（见第 4 条）

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.

EN 10228-3 按照形状和生产方法分类，适用于四种类型的锻造件。第 1，2 和 3 类型主要是简单的形状。第 4 类型包括复杂的形状。

This part of EN 10228 does not apply to:

EN 10228-3 不适用于以下的情况：

- closed die forgings;
- turbine rotor and generator forgings.
- 闭式模子锻件；
- 水轮机转子和电机锻造件

Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings is the subject of Part 4 of this European Standard.

奥氏体和奥氏体-铁素体不锈钢的超声波试验属于本欧洲标准的第 4 部分。

2 Normative references

2. 规范性参考文件

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 10228 的本章节，包括有标明日期的和未标明日期的来自其他出版物的条款。这些规范性参考文件标注在本文本的适当的位置，**将这些出版物在下面列出**。对于表明日期的参考，后来的修改或这些出版物的任何的修正，只有当通过修改或修正结合时才应用于 EN 10228 的组成部分。对于未标注日期的参考，采用出版物的最新的版本。

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.*

EN 473, 无损探伤试验人员的资格和证明

PrEN 12668-1 无损探伤试验人员-超声波检验设备的特征和确认-第 1 部分: 仪器

PrEN 12668-2 无损探伤试验-超声波检验设备的特征和确认-第 2 部分: 探头

PrEN 12668-3 无损探伤试验-超声波检验设备的特征和确认-第 3 部分: 组合式设备

PrEN 583-2 超声波检验-第 2 部分, 灵敏度和范围设定

PrEN 583-5 超声波检验-第 5 部分, 不连续缺陷的特征和尺寸大小

PrEN 12223 超声波检验- 校准试块

PrEN 1330 无损探伤 – 术语- 第 4 部分; 在超声波试验中所使用的术语

3 Definitions

3. 定义

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

作为 EN 10228 本章节的目的, 在 PrEN 1330-4 中所给出的定义是适用的。

4 Items for agreement

4. 协议的项目

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

在购货方和供货方之间在询价和订货时应该对以下有关超声波试验问题达成协议。

- 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).
- a) 在哪个制造阶段应该进行超声波试验 (见第 9 条);
 - b) 试验的容量和是否要求格栅扫描或 100% 的扫描范围。(见第 12 条);
 - c) 近表面检验的双晶体探头的使用 (见 7.2.6);
 - d) 所要求的质量等级, 或适用的质量等级和分类 (见第 14 条);
 - e) 如果与表 5, 6 或表 7 中的详细内容不同, 适用的记录/接受标准;
 - f) 除了在第 7 和第 12 条中详细内容外, 是否要求任何特殊的扫描, 设备或耦合剂;
 - g) 使用的扫描技术如果不是手工的 (见第 1 条款)
 - h) 对于延长性不连续缺陷使用的标定技术 (15 条)
 - i) 设定灵敏度使用的技术 (11 条)
 - j) 是否在购货方或其代表出场的情况下进行试验。
 - k) 对于购货方的批准, 是否提交书面程序 (见第 5 条)

5 Written procedure

5. 书面程序

5.1 General

5.1 概述

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.

超声波试验应该按照书面程序进行。在询价和订单规定的情况下，在测试之前，将书面程序呈交给购货方进行批准。

5.2 Form

5.2 格式

This written procedure shall be in the form of:

本书面程序应该按照以下的格式：

- 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.

- a) 产品技术规格
- b) 专门用于应用的书面程序，或者
- c) EN10228-3 及其附带的探伤细节说明一起应用。

5.3 Content

5.3 目录

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

书面程序应至少包括以下的细节：

- 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.

- a) 对进行检验的锻造件的描述
- b) 参考文献
- c) 检验人员的资质和证明
- d) 在何制造阶段进行 UT 检验
- e) 按照适用的质量等级规定的检验区

- f) 扫描表面的准备
- g) 耦合剂
- h) 检验设备的描述
- i) 校准预设
- j) 扫描计划
- k) 检验操作的描述与程序
- l) 记录/评价等级
- m) 不连续的特征
- n) 接受标准
- o) 检验报告

6 Personnel qualification

6. 人员资格

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

应该按照 EN473 评定人员资格和证明

7 Equipment and accessories

7. 设备与附件

7.1 Flaw detector

7.1 探伤仪

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

探伤仪应对 A-扫描提供特征并符合 prEN 12668-1 的要求

7.2 Probes

7.2 探头

7.2.1 General requirements

7.2.1 一般要求

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

直探头和横波探头应该符合 prEN 12668-2 的要求。

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.

在需要另外资料的情况下，也可以采用补充探头。对于缺陷的初始探测，不应该使用补充探头。建议补充探头应符合 prEN 12668-2 的要求。

7.2.2 Contouring

7.2.2 描绘轮廓

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

当 EN-583-2 要求的时候，探测器应描绘缺陷的轮廓。

7.2.3 Nominal frequency

7.2.3 标称频率

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

探头应该具有从 1 兆赫至 6 兆赫范围的标称频率

7.2.4 Normal probes

7.2.4 直探头

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

有效的晶体直径应在 10 毫米-40 毫米的范围内。

7.2.5 *Shear wave probes*

7.2.5 横波探头

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.

横波探头光束角应在 35- 70 度的范围内。

有效的晶体区域应在 20 平方毫米-625 平方毫米的范围内。

7.2.6 *Twin crystal probes*

7.2.6 双晶体探头

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

如果需要进行近表面检验, (见第 4 条), 那么一定要使用双晶体探头。

7.3 *Calibration blocks*

7.3 校准模块

Calibration blocks shall conform to prEN 12223.

校准模块一定要符合 pr EN12223。

7.4 *Reference blocks*

7.4 参考模块

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.

当由距离振幅曲线 (DAC) 技术建立灵敏度时和/或通过 DAC 技术将缺陷按照振幅相关参考反射体进行大小排列时, 应该使用参考模块。参考模块的表面条件应该作为部件表面条件的代表进行检验。除非另有说明, 参考模块应该至少包含检验时涵盖整个深度范围的三个反射体。

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

参考模块的形式取决于具体的应用。应该由下面部件中的其中一个制成:

- 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.
- a) 需要被检验部件的多余的长度; 或者
 - b) 和需要被检验的部件材质和热处理条件一样的一个部分; 或者
 - c) 和需要被检验的部件声学特性相似的一个部分;

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.

除非要求检查特定 DGS 曲线的精确性, 否则参考模块不能用于距离增益尺寸 (DGS) 技术。

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.

注意: 参考模块中反映体的尺寸受到表格 5 和表格 6 的详细尺寸的限制。使用表格 5 和表格 6 种提供的详细反映体的尺寸, 得到的试验灵敏度也相应是正确的。

7.5 Couplant

7.5 耦合剂

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.

使用的耦合剂一定要适合相应的应用。进行校准，设置灵敏度，扫描和缺陷评估时要使用同样类型的耦合剂。

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.

在完成检验后，如果耦合剂的存在会对以后的生产或检验操作或部件的完整性产生不利影响的话，应将其清除。

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

注意：合适的耦合剂有：水（带有或不带有防腐剂或软化剂），润滑脂，油，甘油和水纤维素糊。

8 Routine calibration and checking

8. 常规校准和检查

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

按照 prEN12668-3 的具体要求，对组合设备（探伤仪和探头）进行校准和检查。

9 Stage of manufacture

9. 制造阶段

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.

除非在询价期或者订单时间内达成协议，否则应该在最终热处理之后执行超声波测试（请见第4条），例如在最终质量热处理后，锻件精加工后某些部位不适宜进行检测。

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

注意：对于需要钻孔的圆柱形和矩形锻件，建议在钻孔之前执行超声波测试。

10 Surface condition

10 表面条件

10.1 General

10.1 总体说明

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.

扫描的表面不能有涂料，非粘性氧化层，干燥耦合剂，不规则表面或者任何可能会降低耦合

剂效用，影响探头自由活动或者造成判断错误的物质。

10.2 Surface finish related to quality class

10.2 有关质量等级的表面精加工

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

表面精加工应该符合所要求的质量等级，（请见表格 1）

Table 1 — Surface finish related to quality class

表格 1- 有关质量等级的表面精加工

Surface finish 表面精加工	Quality class and roughness R_a 质量等级和粗糙度 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 Machined and heat treated 经过机械加工的 经过机械加工和热处理的	X X	X X	X X	X —
NOTE X signifies the quality class that can be achieved for the specified surface finish. 注释：X 的意思是规定表面精加工可以达到的质量等级				

10.3 As-forged surface condition

10.3 锻造后的表面条件

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.

当锻件的状态处于锻造后的表面条件时，可以考虑接受，如果达到了规定的质量等级。

注意 在锻造后的表面上很难执行全面的检验时，建议进行喷丸清理，喷沙清理或者表面修磨来保证维持超声波耦合。通常只能应用质量等级 1。

11 Sensitivity

11 灵敏度

11.1 General

11.1 总体说明

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).

灵敏度一定要足以保证记录/评价等级要求中需探测的尺寸最小的不连续，以符合规定的特定质量等级（见表格 5.6 和表格 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.

应该使用 11.2 和 11.3（DAC 或 DGS）明细中指出的技术之一来建立使用特定探头进行扫描的灵敏度（见第 4 条）。每种情况下采用的程序都应该符合 prEN583-2 的要求。

11.2 Normal probes

11.2 直探头

- a) Distance amplitude curve (DAC) technique based upon the use of flat-bottomed holes;
- b) Distance gain size (DGS) technique.

- a) 距离振幅曲线 (DAC) 技术基于平底孔的使用;
- b) 距离增益尺寸 (DGS) 技术;

11.3 Shear wave probes

11.3 横波斜探头

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

- a) 使用 3 毫米直径侧面钻孔的 DAC 技术;
- b) DGS 技术。

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

DAC 和 DGS 技术的不同横波探头不能进行比较。

11.4 Repeat inspection

11.4 重复检验

Where repeat inspection is performed, the same technique for establishing sensitivity (DAC or DGS) shall be used as was initially used.

在执行重复检验的情况下, 使用最初使用的技术来建立灵敏度 (DAC 或 DGS)。

12 Scanning

12. 扫描

12.1 General

12.1 总体说明

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

应该使用接触脉冲回波技术。

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).

要求的最小扫描范围是由锻件的类型和询价或者订单中规定的网格扫面覆盖率或者 100% 扫描覆盖决定的 (请见第 4 条)。

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).

在表格 2 中, 根据形状和生产的方法将锻件分为四类。

在表格 3 中, 规定了锻件 1, 2, 3 类纵波扫描覆盖的要求。

在表格 4 中, 规定了 3a 和 3b 类其外径和内径比小于 1.6 比 1 的锻件的横波扫描覆盖的要求。周向横波扫描的有效深度受到探头角度和锻件直径的限制 (见附录 A)。

12.2 Complex forgings

12.2 合成锻件

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 %).

合成型锻件或者锻件的合成部分（4 类）和小直径锻件的扫描覆盖需要买卖双方询价时以及订单中达成共识（请见第 4 条）。这就应该至少包括要求的探头角度，扫描方向和扫描覆盖范围（网格或 100%）。

12.3 Grid scanning coverage

12.3 网格覆盖范围

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

网格扫描应该用探头沿着表格 3 和 4 中规定的网格线进行扫描。

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

如果通过网格扫描而显示出有记录价值的指示，那么应该在出现指示的区域继续扫描以确定其范围。

12.4 100 % scanning coverage

12.4 100% 扫描覆盖

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.

100%扫描覆盖应该按照表格 3 和表格 4 中规定的表面，使用探头进行横向的重叠连贯的扫描，至少要使用探头有效直径的 10%进行扫描。

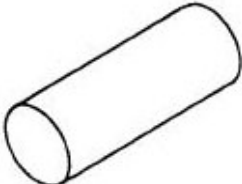
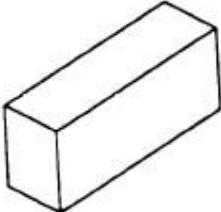

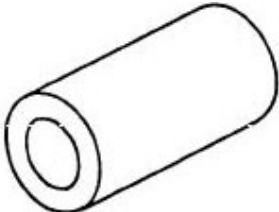
12.5 Scanning speed

12.5 扫描速度

Manual scanning speed shall not exceed 150 mm/s.

手动扫描速度不能超过 150mm/s。

Table 2 — Classification of forgings according to their shape and method of production**表格 2- 根据形状和生产的方法将锻件分为四类**

Type 类型	Shape 形状	生产方法
1a ²⁾	<p>Elongated with round or approximately round section, e.g. bars, rods, cylinders, shafts, journals, discs cut from bars 圆</p> <p>形或者近似于圆形部分的延伸，例如棒类，杆类，圆柱类，轴类，枢轴类，棒类切割下来的圆盘类</p> 	Direct forged. 直接锻造
1b ²⁾	<p>Elongated with rectangular or approximately rectangular section, e.g. bars, rods, blocks, sections cut from bars</p> <p>矩形或者近似于矩形部分的延伸，例如棒类，杆类，块类，棒类切割下的横截面。</p> 	
2 ^{3) 4)}	<p>Flattened, e.g.: discs, plate, flywheels</p> <p>扁平材，例如：圆盘材，板材，飞轮</p> 	Upset 墩粗
3a	<p>Hollow cylindrical shapes, e.g.: bottles, compressed gas tanks</p> <p>空心圆柱形状，例如：瓶子，压缩气体罐</p> 	Mandrel forged 心轴锻造

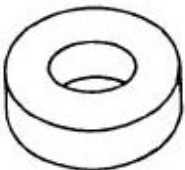

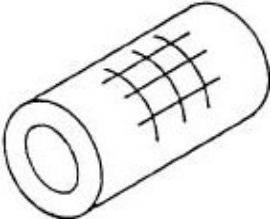
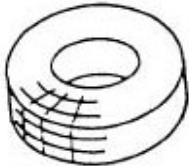
3b	Hollow cylindrical shapes, e.g.: rings, flanges, rims 空心圆柱形状，如：环，法兰，轮缘	Expanded 膨胀延伸
		
3c		
4	All forgings or parts of forgings with complex shape 合成型锻件或者锻件的一部分	Various 多种
<p>Notes:</p> <p>1) The purchaser shall be informed of the method of production at the time of enquiry and order.</p> <p>2) Type 1 forgings may incorporate bores of small diameter relative to the major dimensions.</p> <p>3) Type 2 forgings may eventually be drilled (e.g.: binding discs).</p> <p>4) Type 2 forgings include products manufactured from forged billets and bars.</p> <p>注意：</p> <p>1) 在询价和订货时，买方应该被告知生产方法。</p> <p>2) 1 型锻件可能会有相对总体尺寸较小直径的孔。</p> <p>3) 2 型锻件可能最终要被钻孔（例如：装配圆盘）。</p> <p>4) 2 型锻件包括由锻坯和棒材生产出的产品。</p>		

Table 3 — Scanning coverage with normal probes

表格 3- 使用直探头的扫描覆盖

Type 类型	Grid Scanning ¹⁾ 网格扫描 ¹⁾		100 % scanning ¹⁾²⁾ 100%扫描 ^{1) 2)}	
1	1a	<p>Diameter, D mm 直径, D 毫米</p> <p>D 小于等于 200 D 大于 200 小于等 于 500 D 大于 500 小于等 于 1000 D 大于 1000</p>	<p>Scan lines³⁾ 扫描线³⁾</p> <p>90 度 2 60 度 3 45 度 4 30 度 6</p>	<p>Scan 100 % around at least 180° of cylindrical surface 扫描圆柱表面至少 180 度的 100%。</p>
	1b	<p>Scan along the lines of a square-link grid on two perpendicular surfaces³⁾⁴⁾ 沿着两个垂直表面³⁾⁴⁾的方块连锁网 格进行扫描。</p>		<p>Scan 100 % on two perpendicular surfaces 扫描两个垂直表面的 100%</p>

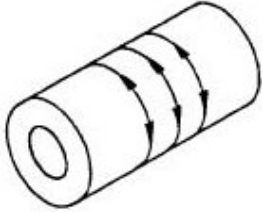

2		Scan along the lines of a square-link grid around 360° on the cylindrical surface and one lateral surface ⁴⁾ 沿着圆柱表面和一个侧面 360 度的方块连锁网格线进行扫描。	Scan 100 % around at least 180° on the cylindrical surface and 100 % of one lateral surface 围绕圆柱表面至少 180 度进行 100% 扫描，对一个侧面进行 100% 扫描。
3	3a 	Scan along the lines of a square-link grid around 360° on the outer cylindrical surface ⁴⁾ 沿着外圆柱表面 ⁴⁾ 进行 360 度的方块连锁网格线扫描。	Scan 100 % around 360° on the outer cylindrical surface 围绕外圆柱表面 360 度进行 100% 扫描。
	3b 和 3c 	Scan along the lines of a square-link grid around 360° on the outer cylindrical surface and one lateral surface ⁴⁾ 沿着外圆柱表面和一个侧面 ⁴⁾ ，围绕 360 度的连锁网格线进行扫描。	Scan 100 % around 360° on the outer cylindrical surface and one lateral surface 围绕外圆柱表面和一个侧面 360 度进行 100% 扫描
4	Scanning coverage shall be specified in the enquiry or order 在询价或订单内应该规定扫描范围		
<p>Notes:</p> <p>¹⁾ Additional scanning (for example in both axial directions for type 3a) may be carried out if specified in the enquiry or order.</p> <p>²⁾ 100 % means at least 10 % probe overlap between consecutive probe traverses.</p> <p>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.</p> <p>⁴⁾ The grid line separation shall be equal to the part thickness up to a maximum of 200 mm.</p> <p>注意</p> <p>1) 如果询价和订单中有特别规定，可能还需要进行额外的扫描（例如 3a 类的 2 个轴向）。</p> <p>2) 100% 的意思是探头连续横向移动之间至少有 10% 的探头重叠。</p> <p>3) 对于 1a 或 1b 类，如果出现孔洞使达到对面表面的过程受到阻碍，那么扫描线应该对称性为原来的 2 倍。</p> <p>4) 网格线之间的距离应该等于部件厚度，不能超过 200 毫米。</p>			

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Table 4 — Scanning coverage with shear wave probes

表格 4- 横波探头的扫描覆盖

Type 类型	Grid scanning ¹⁾ 网格扫描 ¹⁾	100 % scanning ¹⁾²⁾ 100%扫描 ¹⁾²⁾
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 围绕圆周的两个方向对外圆柱表

		<p>沿着两个方向围绕圆周的 360 度的网格线进行扫描, 扫描线之间的距离应该等于直径厚度, 最大不能超过 200 毫米。</p>	<p>面进行 100% 扫描。</p>
3b			
4	<p>Scanning coverage shall be specified in the enquiry or order 在询价或订单中应该规定扫描覆盖</p>		
<p>Notes</p> <p>1) Additional scanning coverage may be carried out if specified in the enquiry or order.</p> <p>2) 100 % means at least 10 % probe overlap between consecutive probe traverses.</p> <p>注意</p> <p>1) 如果在询价或订单中另有规定, 还需要进行额外的扫描覆盖。</p> <p>2) 100%的意思是探头连续横向移动之间至少有 10% 的探头重叠</p>			

13 Classification

13 分类

13.1 Classification of indications

13.1 指示分类

Indications shall be classified according to their echodynamic patterns.

可根据回波动态波形将指示分为若干类。

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.

a) 形式 1

在探头运动时, A-扫描显示器显示出单一的明显的上升指示, 慢慢上升到最高振幅后慢慢下降为零 (见图 1)。

这种形式反映的情况是不连续尺寸小于或等于 -6 dB 光束波面, 例如从用于绘制梁剖面图的边部钻孔而得到的回波动力形式。

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.

b) 形式 2

在探头运动时，A-扫描显示器显示出单一的明显的上升指示，慢慢上升到最高振幅后，保持在最高振幅，伴有振幅变化或没有振幅变化，然后慢慢下降为零（见图 2）。这种形式反映的情况是不连续尺寸大于-6dB 光束波面。

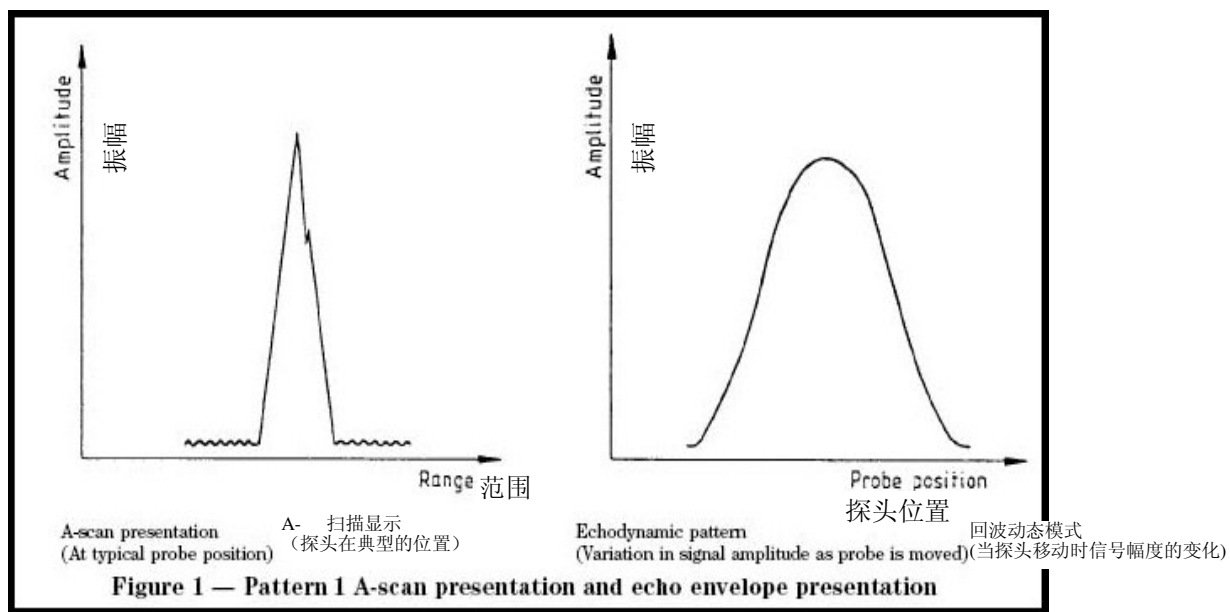


图 1 ——模式 1A-扫描显示和回波动态轮廓显示

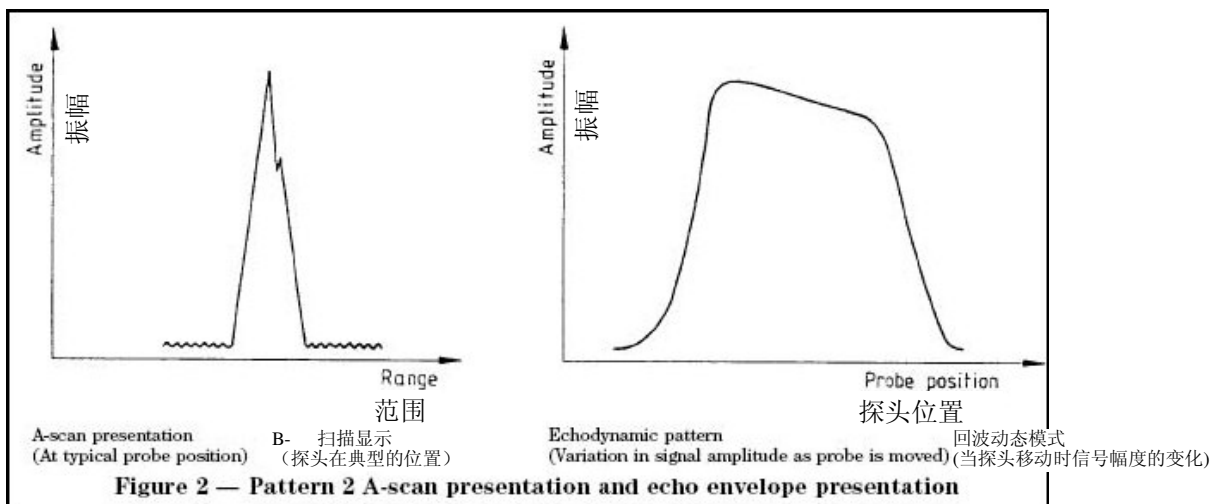


图 2 ——模式 2 A-扫描显示和回波动态轮廓显示

13.2 Classification of discontinuities

13.2 不连续的分类

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

不连续将按照它们的回波动态模式进行分类，分类情况如下：

a) Point discontinuity

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

a) 点不连续

回波动态模式 1 和/或尺寸等于或小于 -6 dB 的探头直径（见图 3）

b) Extended discontinuity

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

b) 扩展不连续

回波动态模式 2 和/或尺寸大于 -6 db 的柱的探头直径（见图 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).

c) 单个不连续

距离 d ，即对应于相邻不连续指示的最大值的点之间的距离，应大于 40 毫米（见图 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).

d) 密集不连续

距离 d ，即对应于相邻不连续指示的最大值的点之间的距离，应小于或等于 40 毫米（见图 6）。

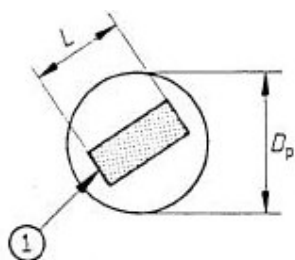


Figure 3 — Point discontinuity
($L > D_p$)

图 3 点不连续 ($L > D_p$)

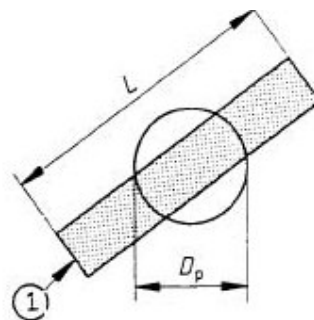


Figure 4 — Extended discontinuity
($L \leq D_p$)

图 4 扩展不连续 ($L \leq D_p$)

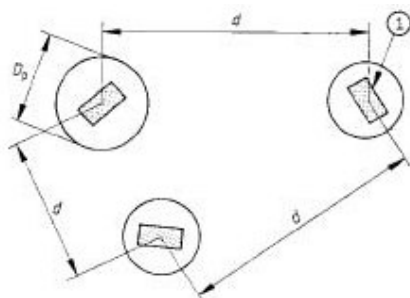


Figure 5 — Isolated point

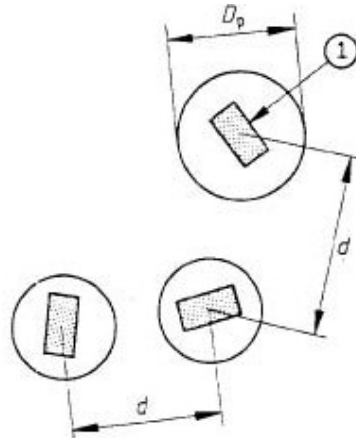


Figure 6 — Grouped point

图 5 单个不连续 ($L \leq D_p, d > 40\text{mm}$) 图 6 密集不连续 ($L \leq D_p, d \leq 40\text{mm}$)

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

使用的符号:

- 1: -6dB 不连续通用的轮廓线
- D_p : 波束在不连续的深度处的宽度
- d : 两个不连续之间的距离
- L : -6dB 不连续的通用长度

14 Recording levels and acceptance criteria

14 记录等级和接受标准

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.

可以使用的质量等级将由购买者和供应商之间协商确定（见条款 4）。表 5、6 和 7 给出了详细的记录等级和接受标准，它们可适用于四个质量等级。

注：有几个质量等级可以适用于锻件和锻件零件；质量等级 4 是最严格的，代表最小的记录等级和接受标准。如能达成协议，则记录/评估等级和接受标准可以与表 5、6 和 7 中的内容不同。

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

表 5 直探头的质量等级，记录等级和接受标准

Parameter 参数	Quality class 质量等级			
	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

记录等级 等效的平底孔 (EFBH) d_{eq} mm ¹⁾ 快速后壁回波减小率 R				
Acceptance criteria EFBH (isolated point type discontinuities) d_{eq} mm ¹⁾ EFBH (extended or grouped point type discontinuities) d_{eq} mm ¹⁾ 接受标准 EFBH (扩展的或成组点类型的不连续) d_{eq} mm ¹⁾	≤ 12 ≤ 8	≤ 8 ≤ 5	≤ 5 ≤ 3	≤ 3 ≤ 2
<p>1) d_{eq} = Diameter of equivalent flat bottomed hole.</p> <p>1) d_{eq} = 平底孔当量的直径</p> <p>2) $R = \frac{F_n}{F_{o,n}}$</p> <p>where:</p> <p>$n = 1$ for $t \geq 60$ mm</p> <p>$n = 2$ for $t < 60$ mm</p> <p>F_n = amplitude (screen height) of the n^{th} reduced backwall echo</p> <p>2) $F_{o,n}$ = amplitude (screen height) of the n^{th} backwall echo in the nearest discontinuity-free area at the same range as F_n. $R = \frac{F_n}{F_{o,n}}$</p> <p>式中: 当 $t \geq 60$ mm 时 $n=1$ 当 $t < 60$ mm 时 $n=2$ F_n = 第 n 个减小背面回波的振幅 (波幅) $F_{o,n}$ = 在最近的无不连续区域且与 F_n 同范围的第 n 个背面回波的振幅 (波幅)</p> <p>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.</p> <p>3) 如果背面回波的减小超过记录等级, 则需要进一步检查。 比率 R 只适用于由不连续引起的背面回波的快速减小。</p>				

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

表 6——使用 DGS 技术带平底孔的横波探头的质量等级和接受标准

Quality class 质量等级	1 ¹⁾	2	3	4
Recording level d_{eq} mm ²⁾ 记录等级 d_{eq} mm ²⁾	—	>5	>3	>2
Acceptance criteria for isolated discontinuities d_{eq} mm ²⁾ 孤立不连续的接受标准 d_{eq} mm ²⁾	—	≤ 8	≤ 5	≤ 3
Acceptance criteria for extended or grouped point type discontinuities d_{eq} mm ¹⁾ 扩展或成组点类型不连续的接受标准 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.

注：1) 横波扫描不适用于质量等级 1。

2) d_{eq} =平底孔当量的直径。Table 7 — Quality classes, recording level and acceptance criteria for shear wave probes using DAC technique¹⁾表 7——使用 DAC 技术的横波探头的质量等级，记录等级和接受标准¹⁾

Quality class 质量等级	Nominal test frequency ³⁾ MHz 标称测试频率 ³⁾ MHz	Recording level % (DAC) 记录等级% (DAC)	Acceptance criteria 接受标准	
			Isolated discontinuities ¹⁾⁴⁾ % (DAC) 孤立不连续 ¹⁾⁴⁾ % (DAC)	Extended or grouped point type discontinuities ¹⁾⁴⁾ % (DAC) 扩展或成组点类型的 不连续 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.

1) 以直径 3 毫米的侧向钻孔为基础。

2) 横波扫描不适用于质量等级 1。

3) 每一个频率和每一个探头都要制作一个以直径 3 毫米侧向钻孔为基础的 DAC。

4) 在附录 B 中给出相对于 DAC 的以 dB 表示的指示幅度。

15 Sizing

15 标定

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.

当需要对不连续的程度进行评估的时候，按照购买者和厂商之间的协议，可以采用下面的一种或多种技术。这些技术必须按照 prEN583-5 中详细提供的要求执行。

- a) 6 dB-drop technique;
 - b) 20 dB-drop technique;
 - c) maximum amplitude technique.
- a) 6 dB 下降技术
 - b) 20 dB 下降技术
 - c) 最大振幅技术

16 Reporting

16 报告

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

所有的测试都是书面报告的内容，报告至少应该包括以下的信息：

- a) name of supplier;
- a) 供应商名称
- b) order number;
- b) 定单编号
- c) identification of forging(s) under examination;
- c) 进行检验的锻件的标识
- d) scope of examination: examination zones and applicable quality classes;
- d) 检测的范围：检测区域和适用的质量等级
- e) stage of manufacture at which ultrasonic testing was performed;
- e) 用超声波进行检测时的制造阶段
- f) surface condition;
- f) 表面状况
- g) equipment used (flaw detector, probes, calibration and reference blocks);
- g) 使用的设备（裂纹探测器、探头、校准块和参考块）
- h) technique(s) used to set sensitivity;
- h) 设置灵敏度所使用的技术
- i) reference to this standard or reference to the written procedure used (where applicable);
- i) 该标准中的参考或书面程序中的参考（当适用时）
- j) results of examination;
- j) 检测结果
- 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;
- k) 超过有关记录或接受标准的所有不连续的位置、分类和振幅（使用 FBH 当量直径术语，或者用 SDH 百分比）
- l) details of any restrictions to the required scanning coverage and if applicable the extent of the near surface zone;
- l) 对要求的扫描范围有所限制的详细内容，以及如果适用的话附近表面区域的大小
- m) date of examination;
- m) 检验的日期
- n) name, qualification and signature of operator;

n) 操作人员的姓名、资格和签名。

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Annex A (informative)

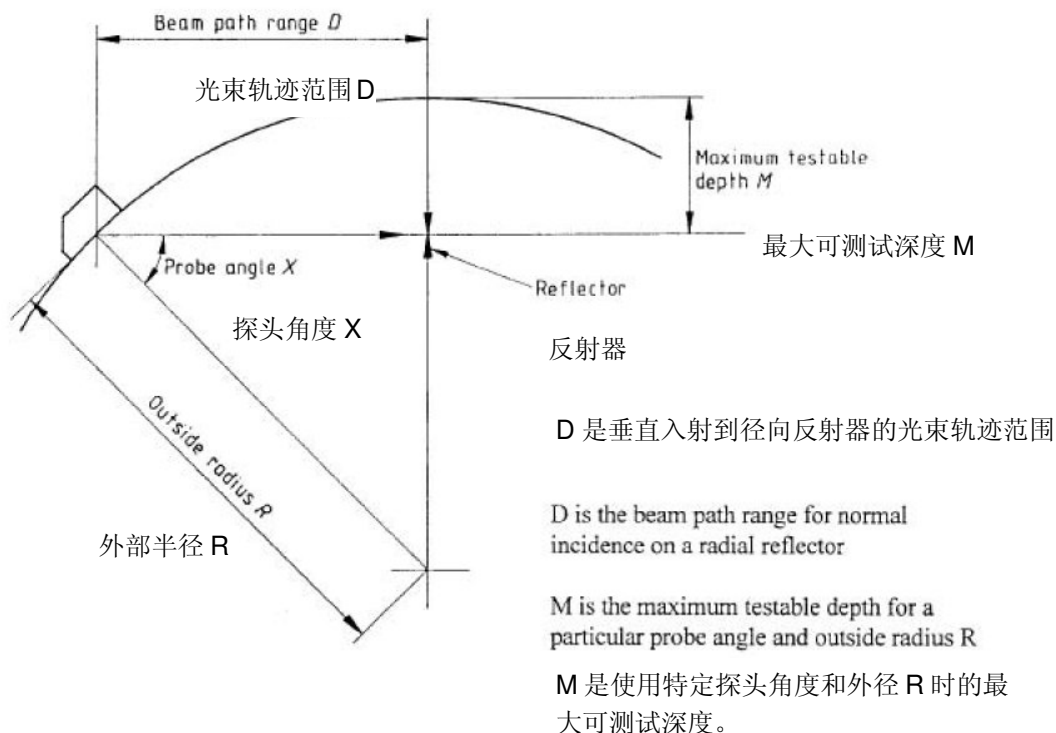
附录 A (参考性的)

Maximum testable depth for circumferential shear wave scans

圆周横波扫描的最大可测试深度

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

图 A.1 表示使用指定的探头和声程范围的横圆周扫描的最大可测试深度。



Probe angle X 探头角度 X	Maximum test depth M 最大测试深度 M	Beam path range D 光束轨迹范围 D
70°	0.06R	0.34R
60°	0.13R	0.50R
50°	0.24R	0.64R
45°	0.30R	0.70R
35°	0.42R	0.82R

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.

注：最大可测试深度和到达最大可测试深度的光束轨迹范围都是以径向反射器锻件的外径 R 表示的。所示的光束轨迹范围 D 的值可以有效地加倍。

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

图 A.1 横圆周扫描的最大可测试深度

Annex B (informative)**附录 B (参考性的)****dB amplitude of indication relative to % DAC****相对于%DAC 指示的 dB 幅度**

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.

作为建造 DAC 的替代方案，它是直径为 3 毫米的侧向钻孔 DAC 的百分比 (100%DAC)，需要的记录或接受等级可以通过建造 3 毫米的 DAC(100%DAC)并按照表 B.1 调整幅度而实现。

Table B.1 — dB amplitude relative to % DAC**表 B.1-相对于%DAC 的 dB 振幅**

DAC %	Amplitude of indication relative to DAC
	dB 相对于 DAC 的指示幅度 dB
30	-10
50	-6
60	-4
100	0
200	+6