BRITISH STANDARD

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13763-4:2003

Explosives for civil uses — Detonators and relays —

Part 4: Determination of resistance to abrasion of leading wires and shock tubes

The European Standard EN 13763-4:2003 has the status of a British Standard

ICS 71.100.30

BSI
British Standards

National foreword

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The UK participation in its preparation was entrusted to Technical Committee CII/61, Explosives for civil uses, which has the responsibility to:

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Summary of pages

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Explosives for civil uses - Detonators and relays - Part 4: Determination of resistance to abrasion of leading wires and shock tubes

Explosifs à usage civil - Détonateurs et relais - Partie 4: Détermination de la résistance à l'abrasion des fils d'amorce et des tubes à transmission d'ondes de choc

Explosivstoffe für zivile Zwecke - Zünder und Verzögerungselemente - Teil 4: Bestimmung der Widerstandsfähigkeit von Zünderdrähten und Zündschläuchen gegenüber Abrieb

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

Ref. No. EN 13763-4:2003 E

Contents

Foreword

This document (EN 13763-4:2003) has been prepared by Technical Committee CEN/TC 321 "Explosives for civil uses", the Secretariat of which is held by AENOR.

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of an identical text or by endorsement, at the latest by May 2004, and conflicting national standards shall be withdrawn at the latest by May 2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

This European Standard is one of a series of standards with the generic title *Explosives for civil uses – Detonators and relays.* The other parts of this series are listed below:

prEN 13763-1 Part 1: *Requirements*.

EN 13763-2 Part 2: *Determination of thermal stability.*

EN 13763-3 Part 3: *Determination of sensitiveness to impact.*

EN 13763-5 Part 5: *Determination of resistance to cutting damage of leading wires and shock tubes.*

EN 13763-6 Part 6: *Determination of resistance to cracking at low temperatures of leading wires.*

EN 13763-7 Part 7: *Determination of the mechanical strength of leading wires, shock tubes, connections, crimps and closures.*

EN 13763-8 Part 8: *Determination of resistance to vibration of plain detonators.*

EN 13763-9 Part 9: *Determination of resistance to bending of detonators.*

EN 13763-11 Part 11: Determination of resistance to damage by dropping of detonators and relays .

EN 13763-12 Part 12: *Determination of resistance to hydrostatic pressure.*

prEN 13763-13 Part 13: *Determination of resistance of electric detonators against electrostatic discharge.*

prEN 13763-15 Part 15: Determination of equivalent initiating capability.

prEN 13763-16 Part 16: *Determination of delay accuracy.*

prEN 13763-17 Part 17: *Determination of no-fire current of electric detonators.*

prEN 13763-18 Part 18: *Determination of series firing current of electric detonators.*

prEN 13763-19 Part 19: *Determination of firing impulse of electric detonators.*

EN 13763-20 Part 20: *Determination of total electrical resistance of electric detonators.*

prEN 13763-21 Part 21: *Determination of flash-over voltage of electric detonators.*

prEN 13763-22 Part 22*: Determination of capacitance, insulation resistance and insulation breakdown of leading wires.*

EN 13763-23 Part 23: *Determination of the shock-wave velocity of shock tube.*

EN 13763-24 Part 24: *Determination of the electrical non-conductivity of shock tubes.*

prEN 13763-25 Part 25: *Determination of transfer capability of surface connectors and coupling accessories.*

prEN 13763-26 Part 26: *Definitions, methods and requirements for devices and accessories for reliable and safe function of detonators and relays.*

CEN/TS 13763-27 Part 27: *Definitions, methods and requirements for electronic initiation system.*

The annexes A and C are informative, annex B is normative.

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

Introduction

During usage on site, the insulation on the leading wires of electric detonators and the plastics tubing of shock tube non-electric detonators can be subjected to many forces, including abrasive forces when drawn over rough surfaces and/or cutting forces when drawn over a sharp edge. In the former, the plastics material is worn away gradually by abrasion. In the latter, the sharp edge cuts directly into the material. This standard deals with the former case by determining the ability of leading wire insulation/shock tube to resist the abrasive forces likely to be experienced in normal use.

1 Scope

This European Standard specifies a method for determining the resistance to abrasion of plastics used as insulating material for leading wires of electric detonators, or used as base material for the tubing of shock tube non-electric detonators.

2 Normative references

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

EN 13857-1:2003, *Explosives for civil uses - Part-1 Terminology.*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO 17025:1999).*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13857-1:2003 apply.

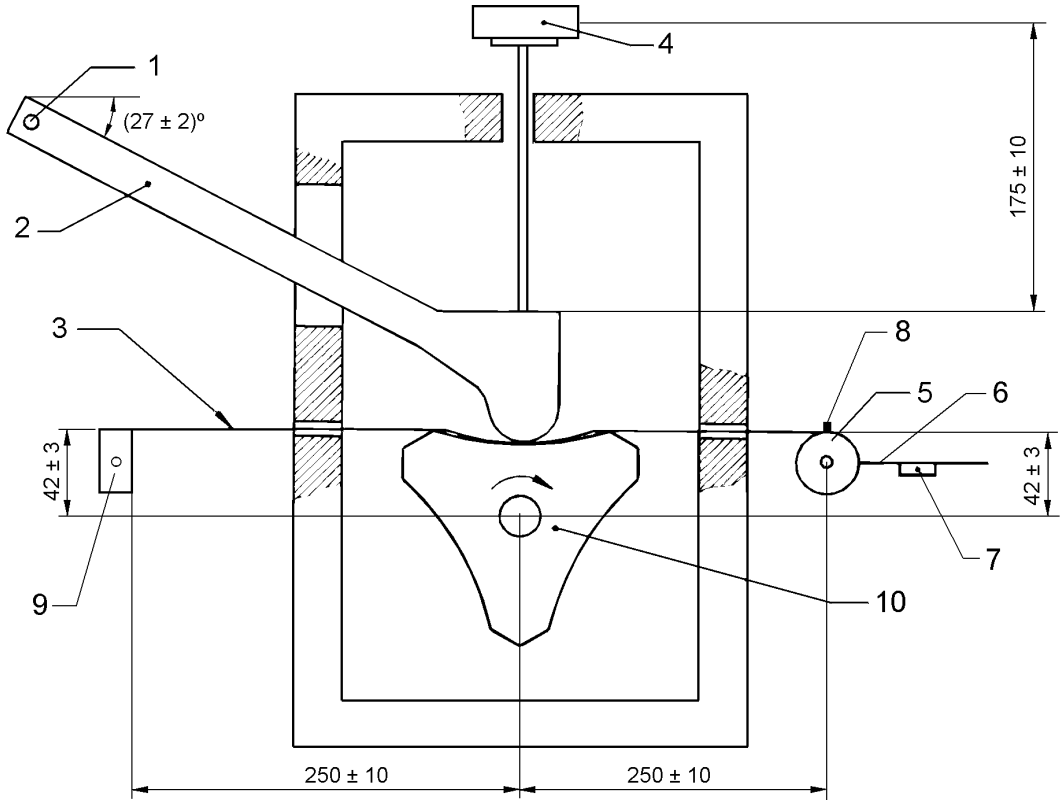
4 Principle

The test piece is subjected to abrasion by an abrasive surface, moving at a specified speed, while a specified load is applied. For leading wires the time taken for the insulation to be penetrated is determined. For shock tubes the functioning of the shock tube after immersion in water is tested.

5 Apparatus

5.1 Abrasion test apparatus, as shown in Figure 1, comprising the following main components.

Dimensions in millimetres



Key

1 Pivot
2 Hinged arm
3 Leading wire/shock tube
4 Weight
5 Pulley
6 Rod
7 Weight
8 Clamp screw for attaching the test piece
9 Clamp for attaching the test piece
10 Rotor

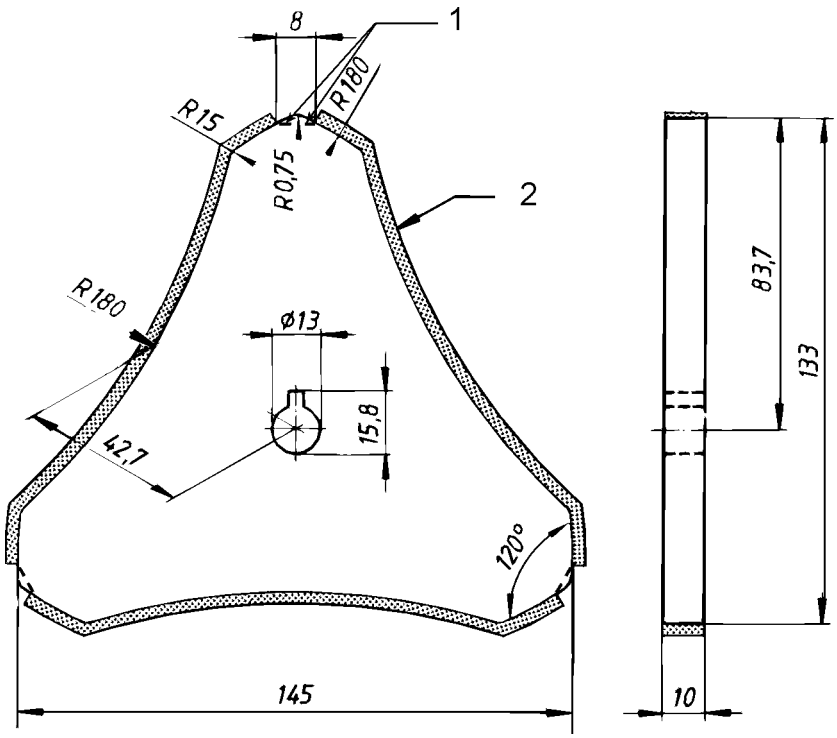
NOTE The weight on the rod to the right of the pulley (diameter 70 mm ± 1 mm) may hang down the right side of the pulley.

Figure 1 – Abrasion test apparatus with rotor in starting position

5.1.1 Steel or brass rotor, as shown in Figure 2, with a perimeter of (453 ± 2) mm to which three abrasive strips (see 5.1.2) are attached by means of glue or double-sided adhesive tape. It shall be ensured that electrical contact between the abrasive strips and the rotor is made, e.g. at the slits on the rotor where the ends of the abrasive strips are inserted (see Figure 2). The rotor shall rotate at a speed of (9,96 ± 0,18) rpm, producing a mean peripheral speed of (0,075 ± 0,001) m/s.

NOTE Depending on attachment principle (glue or tape) of the abrasive strip to the rotor, the abrasive strip may have to be bent carefully using a suitable tool in order to fit properly against the surface of the rotor.

Dimensions in millimetres



Key

1 Slit for the end of the abrasive strip

2 Abrasive strip

Figure 2 – Rotor

5.1.2 Abrasive strips, three pieces approximately 10 mm × 145 mm each, made of grinding steel as specified in annex B.

5.1.3 Load, to be applied to the test piece through the hinged arm (see 5.1.4).

5.1.4 Hinged arm, made of steel or brass as shown in Figure 3. In the starting position, the hinged arm shall apply a load of (8,35 ± 0,05) N to the test piece.

5.1.5 Pulley, diameter (70 ± 1) mm, for applying a tensile load of (8,1 ± 0,5) N to the test piece, by means of a rod and a weight.

5.1.6 Motor, capable of maintaining a constant speed of rotation whatever load is applied to the rotor.

NOTE 1 A DC motor with an output power of at least 500 W and with a separate speed control can be used.

The rotor shall reach its specified speed of rotation 0,6 s after starting.

NOTE 2 This requirement can be verified by two electrodes about 20 mm apart, each adjusted to give electrical contact to the tips of the rotor during rotation. The electrodes are connected to a digital counter, counting elapsed time between the pulses from the two electrodes when they are touching the tips of the rotor. Comparison is made between the elapsed time during a continuous run at the specified speed and the elapsed time 0,6 s after start. First the rotor is rotated manually to an appropriate position in order for a tip of the rotor to reach the second electrode after 0,6 s.

The electrodes can also be used for calibrating the specified speed of rotation, e.g. by measuring the time for one revolution. In this case only one electrode is required.

5.1.7 Digital timer with relay output, capable of:

- being set to a predetermined time in the range of (0 to 10) s ± 0,1 s;
- being started (triggered) when the hinged arm is lifted by the test piece;
- automatically stopping the rotor when the predetermined time has elapsed (only required for shock tube testing);
- automatically stopping the rotor when electrical contact is made between the leading wire and the abrasive strip or the rotor (only required for leading wire testing).

Dimensions in millimetres

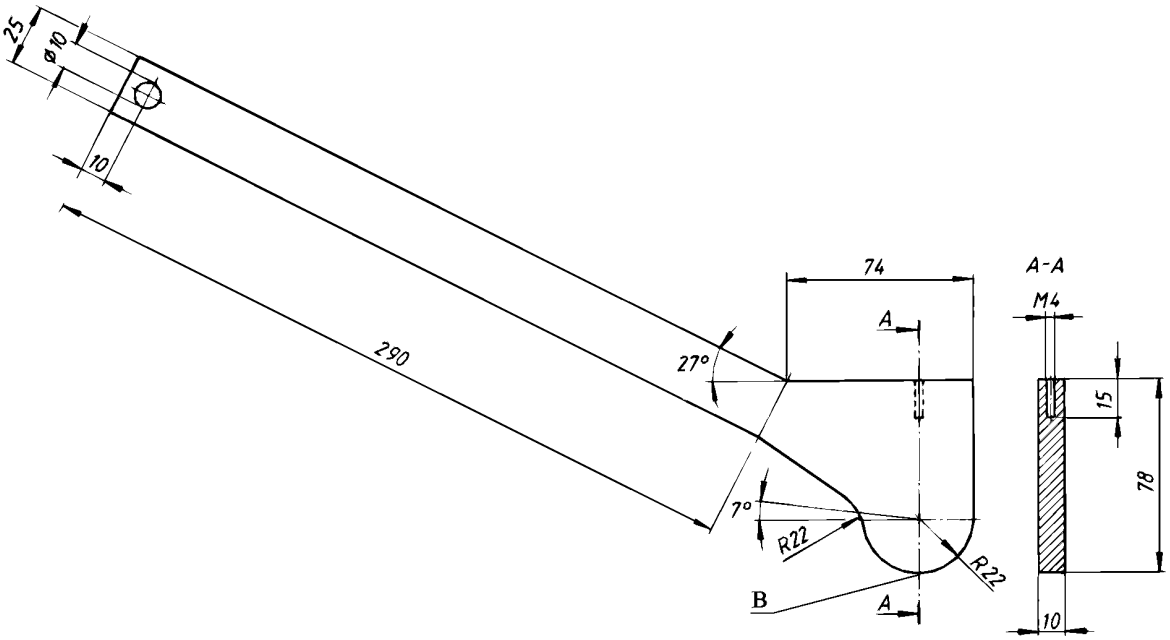


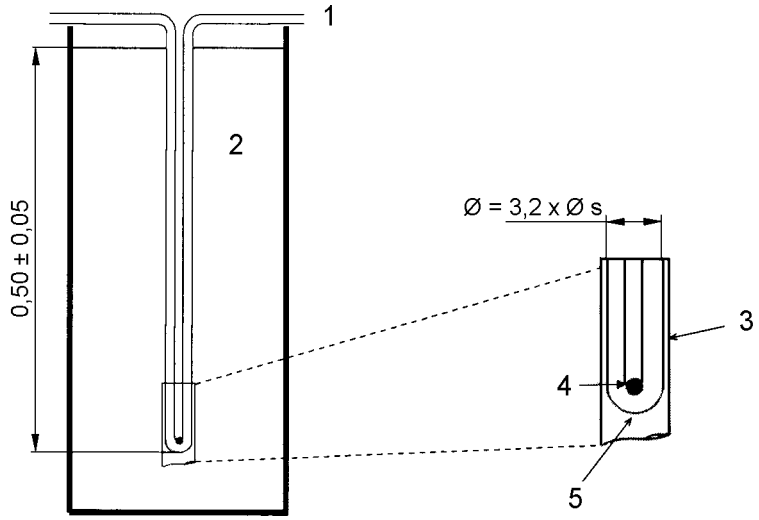
Figure 3 – Hinged arm

5.2 Immersion test apparatus, as shown in Figure 4, comprising the following components.

5.2.1 Cylindrical bending rig, capable of bending and maintaining the test pieces of shock tube in a ”U” form with a bending radius of (1,6 ± 0,1) times the diameter of the shock tube.

5.2.2 Tank of water, deep enough to allow the abraded surface of shock tube to be immersed to (0,50 ± 0,05) m**.**

Dimensions in metres



Key

1 Shock tube
2 Water
3 Cylindrical bending rig
4 Rod with a diameter equal to the diameter of the shock tube (Φ_s)
5 Abraded surface of shock tube on the outer radius

Figure 4 – Water tank and bending rig

5.3 Conditioning chamber, capable of maintaining the highest temperature ± 2 °C claimed by the manufacturer.

6 Test pieces

6.1 Leading wires

Select 10 lengths of leading wire, each at least 0,7 m long, from 10 detonators having the same leading wire construction, composition and dimensions. The test pieces can be selected from detonators, from which the pieces are cut, or from wires of the same specification supplied by the manufacturer of the detonator.

6.2 Shock tubes

Select 10 lengths of shock tube, each (3,0 ± 0,5) m long, from 10 detonators having the same shock tube construction, composition and dimensions. The test pieces can be selected from detonators, from which the pieces are cut, or from shock tubes of the same specification supplied by the manufacturer of the detonator.

7 Procedure

7.1 Conditioning

Condition the test pieces in the conditioning chamber at the highest temperature claimed by the manufacturer ± 2 °C for at least 2 h prior to testing.

7.2 Leading wires

Attach each test piece to the attachment points as shown in Figure 1, e.g. by suitable clamping at the attachment points. If the detonator has twin wires they shall not be separated and shall be parallel and flat at the start of testing.

Position the rotor as shown in Figure 1, which shows the starting position.

Lift up the hinged arm (72 ± 2) mm above the centre of the rotor and fix it in that position using a retaining pin or similar arrangement.

Adjust the tensile load to 8,1 N.

Load the hinged arm with (4,00 ± 0,02) N for category 1, or (12,20 ± 0,02) N for category 2 (excluding the adjusted load due to the hinged arm itself), depending on the category claimed by the manufacturer.

Carry out the test at the upper temperature limit stated by the manufacturer ± 2 °C.

Start the motor.

The timing mechanism shall be started automatically as the hinged arm is lifted by the test piece.

Remove the retaining pin.

The rotor shall be stopped automatically when penetration through the insulation occurs (detected by electrical contact being made between the leading wire conductor and the abrasive strip or the rotor).

Record the time taken from the start of the test until failure, i.e. penetration of the insulation.

NOTE After each test the abrasive strip should be cleaned: for example, by using a brush with plastic bristles. The abrasive strip can be used for several tests but should be changed at suitable intervals based on practical experience of the degradation of the strip. The degradation of the strip can be monitored during routine testing by periodically testing a new set of ten category II leading wires known to give a mean time at failure of approximately 5 s with a new abrasive strip. Then it should be ensured that the mean time at failure for each subsequent set of these wires has not increased by more than 5 % of the mean time at failure for the original set of wires (used with the new abrasive strip).

7.3 Shock tubes

Attach each test piece to the attachment points as shown in Figure 1, e.g. by suitable clamping in order to prevent the test piece from damage at the attachment points.

Position the rotor as shown in Figure 1, which shows the starting position.

Lift up the hinged arm (72 ± 2) mm above the centre of the rotor and fix it in that position using a retaining pin or similar arrangement.

Adjust the tensile load to 8,1 N.

Load the hinged arm with (12,20 ± 0,02) N (excluding the adjusted load due the hinged arm itself).

Carry out the test at the upper temperature limit stated by the manufacturer ± 2 °C.

Start the motor.

The timing mechanism shall be started automatically as the hinged arm is lifted by the test piece.

Remove the retaining pin.

The rotor shall be stopped automatically by the timing mechanism after (6,50 ± 0,05) s.

Remove the shock tube from the apparatus.

NOTE After each test the abrasive strip should be cleaned: for example, by using a brush with plastic bristles. The abrasive strip can be used for several tests but should be changed at suitable intervals based on practical experience of the degradation of the strip. The degradation of the strip can be monitored as described in the note to 7.2, using sets of category II leading wires.

Attach the shock tube to the ”U” shaped bending rig so that the abraded surface is on the outer radius of the bend.

Put the shock tube and the bending rig into the tank of water so that the free ends are above the water and the abraded surface is below the water at a depth of (0,50 ± 0,05) m. See Figure 4.

Store for 24 h at (20 ± 5) °C.

After storage in water, remove the shock tube and attempt to initiate it using the manufacturer’s recommended initiating device.

Record whether or not the tube initiates. If the tube initiates, record whether or not it propagates along its entire length.

8 Test report

The test report shall conform to EN ISO/IEC 17025. In addition, the following information shall be given:

a) for leading wires, the elapsed time at failure;

b) for shock tubes, the number of shock tubes that did not initiate during the functioning test;

c) for shock tubes, the number of shock tubes that did not propagate along their entire length during the functioning test.

Annex A
(informative)

Range of applicability of the test method

Range of applicability of the test method:	- 30 °C to + 80 °C

Annex B
(normative)

Specification of grinding steel

B.1 Type

Grinding steel manufactured by using a chemical etching process.

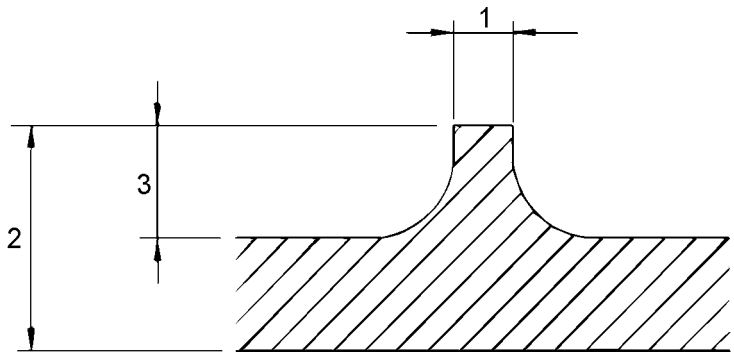
B.2 Material

Martensitic stainless steel.

B.3 Dimensions

The cross section dimensions of the grinding steel shall comply with Figure B.1. The values indicated refer to the mean values for the set of abrasive strips required for testing i.e. the mean value for three strips, each with a size of 10 mm x 145 mm.

NOTE The conformity of the strips against the specified tolerances can be verified by selecting an appropriate number of measurement points on a representative area of the grinding steel.



Key

1 Mean value, diameter 0,06 mm to 0,13 mm

2 Mean value, thickness 0,27 mm to 0,35 mm

3 Mean value, depth 0,14 mm to 0,20 mm

Figure B.1 – Cross-section of grinding steel

The cutting point pattern of the grinding steel shall comply with Figure B.2. The cutting points of the grinding steel are distributed in circular sections orientated as in Figure B.2 a). Each section contains seven circular rows around a centre cutting point. The cutting points are placed on these circular rows. The circular diameters and number of cutting points are given in Table B.1.

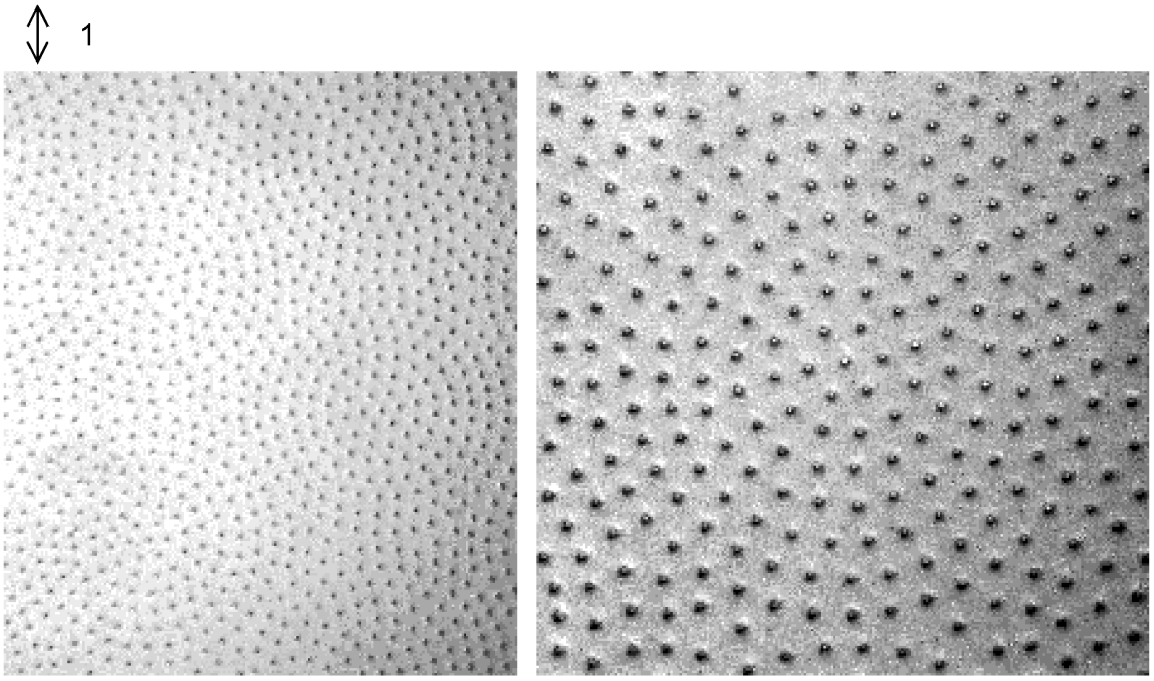


Figure B.2 a) – Cutting point pattern for circles related to the length direction of strips

Figure B.2 b) – Cutting point pattern for one circle

Key

1 Length direction of cut abrasive strip (10 mm x 145 mm)

Figure B.2 – Cutting point pattern of grinding steel

Abrasive strips shall be cut to size (see 5.1.2) from the grinding steel. The strips shall be cut in the direction indicated in Figure B.2 a) related to the cutting point pattern. The centres of the circles shall coincide with the centre of the strip indicated in Figure B.2 b).

Table B.1 – Circular diameters and number of cutting points

Row Number	Diameter (± 5 %) mm	Number of cutting points
1	1,6	6
2	3,1	12
3	4,7	18
4	6,2	24
5	7,8	30
6	9,3	35
7	10,9	41

Annex C
(informative)

Availability of abrasive strips

The commercial availability of the grinding steel required for the abrasive strips, specified in annex B, has been checked and because it is not widely available, it was considered convenient to provide a contact point for obtaining such material, as follows:

SP – Swedish National Testing and Research Institute
Department of Electronics
Box 857
S-501 15 Borås
Sweden
Tel. : +46 33 16 50 00
Fax: +46 33 13 55 02
E-mail: info@sp.se

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Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

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WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The clauses of this standard are likely to support requirements I.1, I.2, II.1.(g), II.1.(j) and II.2.C.(f) of Directive 93/15/EEC.

Compliance with this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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