INTERNATIONAL STANDARD 2251

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Lined antistatic rubber footwear

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2251 was drawn up by Technical Committee ISO/TC 45, *Rubber and rubber products*, and circulated to the Member Bodies in February 1974.

It has been approved by the Member Bodies of the following countries :

Belgium	Netherlands	Thailand
Czechoslovakia	New Zealand	Turkey
Egypt, Arab Rep. of	Poland	United Kingdom
France	Romania	U.S.A.
Germany	South Africa, Rep. of	U.S.S.R.
Hungary	Spain	Yugoslavia
India	Sweden	
Mexico	Switzerland	

The Member Body of the following country expressed disapproval of the document* on technical grounds :

Canada

* clause 8 only.

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Lined antistatic rubber footwear

0 INTRODUCTION

This International Standard applies to lined rubber footwear with antistatic properties for special purpose applications where portable electrical equipment may be used, or where potential electrical defects from other causes may develop, and where it is consequently necessary to have a lower limit on resistivity (upper limit on conductivity).

Experience has shown that for antistatic purposes the discharge path should have an electrical resistance not greater than 10^8 Ω at any time throughout its useful life. A value of $5{,}0 \times 10^4$ Ω for antistatic products is suggested as the lowest limit of resistance to give adequate protection against fire and dangerous electric shock in the event of any apparatus becoming defective when operating up to 250 V. During service the resistance of footwear made from antistatic material may change significantly. The user is recommended to carry out the test for electrical resistance at frequent intervals and after not more than 200 h wear.

No insulating element should be introduced between the foot of the wearer and the insole of the footwear.

The floor surfaces of rooms where the footwear will be used shall also be antistatic.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the requirements for rubber footwear with antistatic properties.

2 REFERENCES

ISO/R 37, *Determination of tensile stress-strain properties of vulcanized rubbers.*

ISO/R 188, *Vulcanized rubbers – Accelerated ageing or heat resistance tests.*

ISO/R 471, *Standard atmospheres for the conditioning and testing of rubber test pieces.*

ISO/R 1421, *Determination of breaking strength and elongation at break of fabrics coated with rubber or plastics.*

3 FABRIC – MINIMUM REQUIREMENTS

3.1 Woven fabrics

The lining of a boot may consist of one fabric forming the leg lining or of two or more fabrics, one forming the leg lining and the other, or others, acting as reinforcement. The strength of the one fabric, or the composite strength if there are more than one, shall be determined in accordance with the method described in annex A, the minimum requirements, for 25 mm wide test pieces, being as shown below :

	Warp	Weft
Upper and vamp	250 N	200 N

3.2 Knitted fabrics

Knitted fabrics may be used by agreement between purchaser and supplier.

4 BOOT UPPER – MINIMUM THICKNESS

The combined thickness of the rubber and fabric shall be not less than the minimum values shown in figure 1 at the points indicated.

5 SPECIAL REINFORCEMENTS

If necessary the top of the boot may be finished off by a top binding or other suitable means.

Eyelets, if fitted, shall be corrosion-resistant and of non-ferrous materials.

6 PHYSICAL PROPERTIES OF SOLING AND HEELS

6.1 Tensile requirements before ageing

Three test pieces shall be cut from both outsoles and heels, then reduced by careful buffing to the thickness required by ISO/R 37, or any other suitable method, taking care to avoid an increase in temperature. The tensile strength and elongation at break of outsoles and heels shall then be determined according to the method described in ISO/R 37, using dumb-bell test pieces. A smaller dumb-bell test piece may be used for the heels, if size makes this necessary. The size of the dumb-bell shall be stated when expressing results.

All three test pieces shall be free from visible defects. If the median of any of the sets of three values determined is below, and the highest value in the set is above, the

appropriate limit given in table 1, two further pieces shall be tested. The material shall be deemed not to comply with the requirements of this International Standard unless the median of each of the sets of five values determined is equal to or above the appropriate value given in table 1.

TABLE 1 – **Tensile and elongation requirements**

	Minimum tensile strength MPa	**Minimum elongation at break** %
Outsoles	8,5	300
Heels	7,0	200

6.2 Tensile requirements after ageing

After submission to the ageing treatment given in table 2 the tensile strength and elongation at break of outsoles and heels determined as above shall be in accordance with the values given in table 2.

TABLE 2 – **Tensile and elongation requirements after ageing**

Ageing treatment	**Tensile strength** % of unaged value		**Elongation at break** % of unaged value
	outsoles	heels	
168 h at 70 ± 1 °C in accordance with the oven method described in ISO/R 188	± 20	± 20	+ 10 − 30

7 SOLING – MINIMUM THICKNESS

The minimum thickness of soling shall be in accordance with the requirements of table 3.

TABLE 3 – **Minimum thicknesses**

Dimensions in millimetres

	Minimum outer sole thickness		**Minimum total thickness** including insole and filling	
	non-cleated	cleated (at cleats)	non-cleated	cleated (at cleats)
Industrial, men's	6,0	11,0*	9,0	14,0**
Industrial, women's	6,0	9,0*	9,0	12,0**
Light	4,0	8,0	7,0	11,0

* Minimum thickness between cleats not less than 4,0 mm.

** Minimum thickness between cleats not less than 7,0 mm.

8 ELECTRICAL RESISTANCE

The resistance of the footwear, when tested by the method described in annex C, shall be between $5{,}0 \times 10^4\ \Omega$ and $5{,}0 \times 10^7\ \Omega$.

9 TESTS

9.1 Leakage test

When finished boots are tested by the manufacturer, there shall be no leakage of air.

After sealing the top of the boots, air shall be forced in, to a pressure of 15 kPa.

The boots shall then be immersed in water to within 75 mm of the top and examined for escape of air.

Ankle boots which show any sign of leakage in the vicinity of either the eyelets or the gusset shall be submitted to an immersion test. The boots shall be weighted and immersed in water to within 75 mm of the top for a period of 16 h and then examined to see if water has penetrated to the inside of the boot.

9.2 Dry heat ageing test

All rubber components shall be capable of withstanding exposure to air at a temperature of 100 ± 1 °C and at atmospheric pressure for a period of 24 h in suitable apparatus, without developing any signs of brittleness or tackiness. For the purpose of this test, the test pieces may be entire articles or pieces cut from them. The test shall be carried out in accordance with the general provisions given in clause 3 of ISO/R 188.

9.3 Flexing test

When tested in accordance with annex B after having been submitted to the dry heat ageing test described in 9.2, the uppers shall withstand not less than the number of continuous flexes given in table 4 without the rubber face showing pinholes or any sign of cracking, and without separation of the plies when viewed with the unaided eye. For this purpose only those parts of the test piece shall be observed which are under tension during the test, i.e. the folds which form a diamond shape. Pinholes or cracking associated with machine damage shall be ignored.

The test pieces shall receive a minimum of 2 days' rest after having been subjected to the dry heat ageing test described in 9.2.

The testing equipment should be kept away from any source of ozone.

TABLE 4 – **Flexing test limits**

Thickness mm	**Minimum number of flexes**	
	handbuilt type	moulded type
up to 2,00	125 000	75 000
over 2,00 up to 2,25	110 000	50 000
over 2,25	90 000	40 000

10 MARKING

Each article of footwear shall be indelibly and legibly marked with the following particulars :

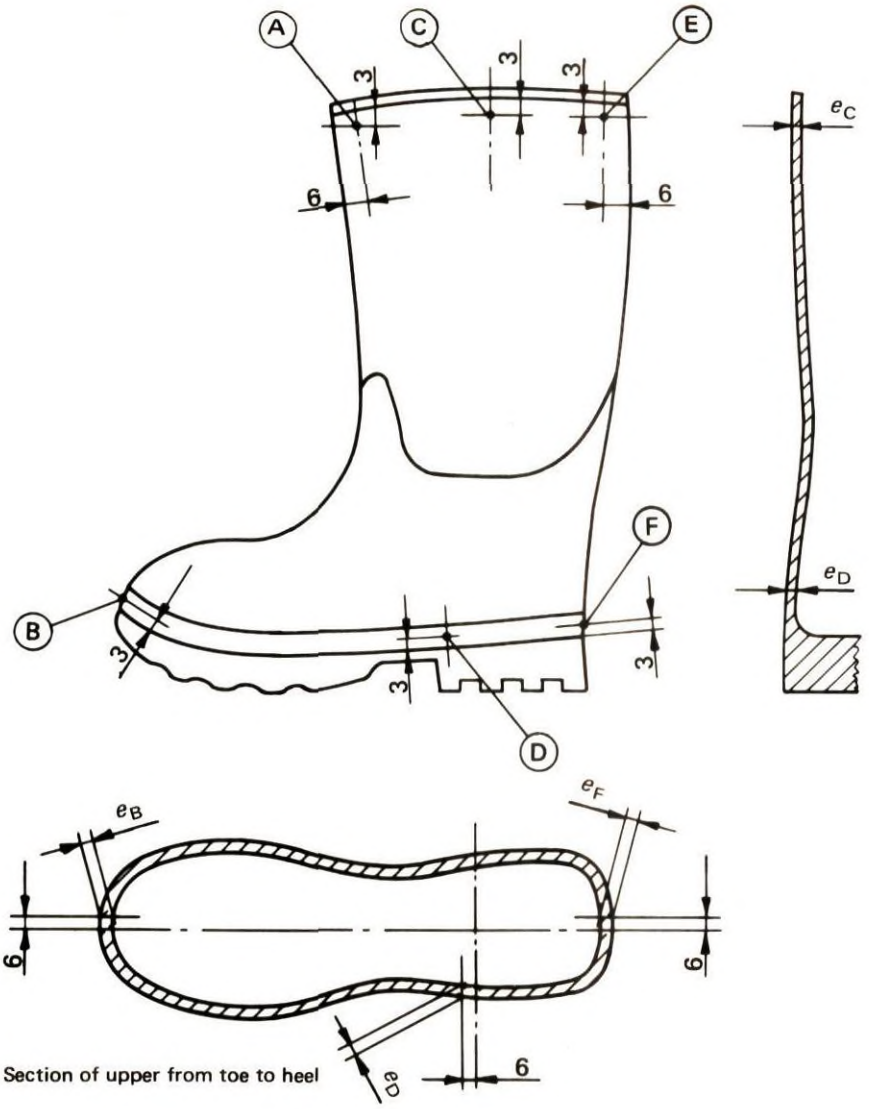
a) *size;*

b) manufacturer's identification;

c) reference number issued by the appropriate national standards organization;

d) in addition, each article of antistatic footwear shall have a lemon-yellow back strip, together with a lemon-yellow rubber label bearing the word "Antistatic" affixed in a suitable position. The words "Test regularly" shall appear on each article either on or near the label.

Dimensions in millimetres



Thicknesses at specified points	
e_A	1,5
e_B	3,5
e_C	1,5
e_D	3,5
e_E	1,5
e_F	4,0

FIGURE 1 – **Lined antistatic rubber boot**

Dimensions in millimetres

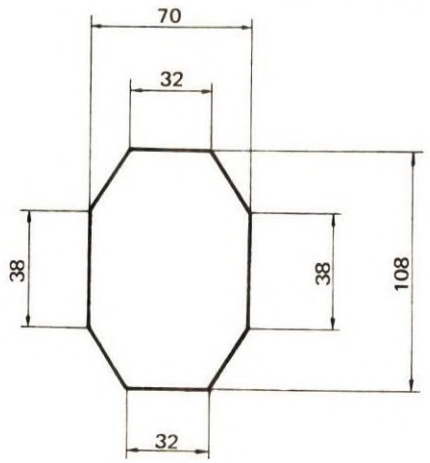


FIGURE 2 – **Test piece for flexing test**

ANNEX A

METHOD OF PREPARATION AND TEST FOR WOVEN FABRICS

Cut strip test pieces of rectangular shape, 25 mm wide, from the upper part of the boot to be tested. These shall cover both warp way and weft way directions of the rubber-coated fabric, and be of sufficient length to permit a free length of 75 mm between the jaws of the fabric strength-testing machine.

Where the height of the product does not permit a sample to be cut giving a free length of 75 mm between the jaws, a free length of 25 mm shall be used.

Except as indicated, these shall be tested for breaking strength in both warp and weft directions in accordance with the requirements of ISO/R 1421, using the cut strip method.

The rate of extension during test shall be 100 ± 10 mm per minute. Alternative speeds of 50 mm per minute or 300 mm per minute may be used when agreed between manufacturer and user.

Preloads applied before carrying out the cut strip test shall be as follows :

1 N for a coated fabric up to 0,2 kg/m².

2,5 N for a coated fabric from 0,2 kg/m² to 0,5 kg/m².

5 N for a coated fabric above 0,5 kg/m².

The test jaws should be set 75 mm or 25 mm apart.

The breaking strength is expressed in newtons (N) in the warp and weft directions for a test piece 25 mm in width.

The length of test piece shall be reported.

ANNEX B

METHOD OF TESTING RESISTANCE TO FLEXING

B.1 APPARATUS

The apparatus shall have the following essential features :

The machine shall have an adjustable stationary part provided with grips 25 mm across, for holding one end of each of the test pieces in a fixed position, and a similar reciprocating part for holding the other end of each of the test pieces.

The reciprocating part shall be arranged so that its motion is in the direction of, and in the same plane as, the centre line between the grips, and its travel shall be adjusted so that the two sets of grips approach each other to a distance of 13 mm and separate to a distance of 57 mm.

The eccentric which actuates the reciprocating part shall be driven by a constant-speed motor to give 340 to 400 flexing cycles per minute, with sufficient power to flex at least six and preferably twelve test pieces at one time.

The test pieces shall be arranged in two equal groups, so that one group is being flexed while the other group is being straightened, thus reducing the vibration in the machine. The grips shall hold the test pieces firmly, and shall enable individual adjustment to be made to the test pieces.

B.2 TEST PIECES

The test piece shall have the dimensions shown in figure 2. Four test pieces shall be cut from the thinnest portion of the leg part of the upper containing the fewest plies of fabric. Care shall be taken to ensure that the test pieces are cut cleanly from the sample material.

B.3 FITTING

The test piece shall be folded symmetrically about its major axis so that the rubber surface is outwards. In the folded condition one tapered end shall be inserted into the fixed central grip and pushed in until the test piece touches the grip pins.

This fixed grip shall then be tightened. The corresponding movable grip shall then be taken out to its fullest extent, the test piece inserted and pulled flat, and the grip tightened. It is recommended that clips be used to keep the edges together during the insertion of the test piece in the grips, but their removal is essential before flexing commences.

NOTE – The test piece shall not be under tension.

B.4 PROCEDURE

A complete to and fro movement of the grip shall be counted as one flex cycle. The length of test shall be calculated in flex cycles and not in time units.

The flex cycle may be determined by using a trip counter operated by one of the movable grips.

The ambient temperature shall be one of the standard temperatures laid down in ISO/R 471 and the temperature used shall be stated in the test report.

ANNEX C

METHOD OF TEST FOR ANTISTATIC FOOTWEAR

C.1 TESTING INSTRUMENT

For resistances below 10^7 Ω, the test should be carried out preferably with an insulation tester having a nominal open circuit voltage of 500 V d.c. or with any suitable instrument known to give comparable results.

For resistances above 10^7 Ω, electronic, electrostatic, or other suitable test instruments should be used.

The instrument should be sufficiently accurate to determine the resistance within 5 % and should not dissipate more than 3 W in the test piece.

The testing instrument should be an insulation tester having the inherent characteristic that the voltage which it applies to the test piece decreases below its open circuit voltage at low resistance values of the test piece. This is a useful characteristic as it reduces the risk of shock and also of overheating the test piece.

Insultation testers of this type may be manually or power driven generators or may be battery or mains operated multi-range instruments with similar characteristics.

The resistance values obtained will vary with the applied voltage and errors may occur when low test voltages are involved. In no cases, therefore, shall the voltage applied to the test piece be less than 200 V.

C.2 LIQUID ELECTRODES AND CONTACTS

Where a liquid electrode is specified it shall be formed on the surface by means of a conducting fluid.

This shall consist of :

- anhydrous polyethylene glycol of molecular mass 600 : 800 parts;
- water : 200 parts;
- soft soap : 1 part.

The electrode area shall be completely wetted and remain so until the end of the test.

Clean metal contacts shall be applied to the wetted area so that the contact area is approximately the same size but not greater than the wetted area.

Alternatively, combined electrodes consisting of a metal electrode enclosed in a water-moistened fabric pad may be used as the wet electrode.

The surface of the product shall not be deformed either during the application of the contacts or during the test.

C.3 PROCEDURE

Procedure A

Place the footwear on a clean dry metal plate with sole and heel in contact.

Apply a metal contact to a liquid electrode 25 mm square situated in the sole or heel area of the inside of the footwear.

Measure the resistance between the electrode and the metal plate.

This reading shall constitute the maximum resistance value.

NOTE – In cases of dispute, the measurements shall be carried out with a force of 45 N applied to the 25 mm square electrode.

Procedure B

Place the footwear on a wetted metal plate with sole and heel in contact.

Apply a metal contact to a liquid electrode 25 mm square situated in the sole or heel area of the inside of the footwear.

Measure the resistance between the electrode and the metal plate, using not less than 200 V.

This reading shall constitute the minimum resistance value.

NOTE – In case of dispute, the measurements shall be carried out with a force of 45 N applied to the 25 mm square electrode.

Both tests described in Procedure A and Procedure B are to be carried out on the same article of footwear.