International Standard 2024

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Rubber footwear, lined conducting — Specification

Chaussures en caoutchouc conducteur, doublées — Spécifications

Second edition — 1981-12-15

UDC 685.314.3 : 678.4/.8 **Ref. No. ISO 2024-1981 (E)**

Descriptors : footwear, rubber products, tests, antistatic agents.

Price based on 7 pages

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 2024 was developed by Technical Committee ISO/TC 45, *Rubber and rubber products.*

This second edition was submitted directly to the ISO Council, in accordance with clause 5.10.1 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 2024-1972), which had been approved by the member bodies of the following countries:

Australia	Greece	Sweden
Austria	Hungary	Switzerland
Belgium	India	Thailand
Canada	Israel	United Kingdom
Czechoslovakia	New Zealand	USA
Egypt, Arab Rep. of	South Africa, Rep. of	USSR
France	Spain	

No member body had expressed disapproval of the document.

Printed in Switzerland

Rubber footwear, lined conducting — Specification

0 Introduction

This International Standard applies to rubber footwear with electrically conducting properties for special purpose applications where risk of electric shock from any electrical apparatus has been completely eliminated and it is necessary to minimize voltage build up and to dissipate static charges in the shortest possible time, for example when handling explosives, and it is not necessary to have a lower limit on resistivity (upper limit on conductivity). In order to ensure that the footwear is definitely conducting, an upper limit of resistivity of 150 000 Ω is specified.

During service, the resistance of footwear made from conducting material may change significantly. The user is, therefore, recommended to carry out the test for electrical resistance at frequent intervals.

The floor surfaces of rooms where the footwear will be used must be conducting.

1 Scope and field of application

This International Standard specifies requirements for rubber footwear with electrically conducting properties.

2 References

ISO 37, *Rubber, vulcanized — Determination of tensile stress-strain properties.*

ISO 188, *Rubber, vulcanized — Accelerated ageing or heat-resistance tests.*

ISO 471, *Rubber — Standard atmospheres, humidities and times for the conditioning and testing of test pieces.*

ISO 1421, *Fabrics coated with rubber or plastics — Determination of breaking strength and elongation at break.*

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 fabric, or the composite strength if there is more than one, shall be determined by the method specified in annex A. The minimum requirements for the upper and vamp, for 25 mm wide test pieces, shall be:

— for the warp direction: 250 N;

— for the weft direction: 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

The top of the boot shall be finished off by a top binding or other suitable means.

Eyelets, if fitted, shall be rust-resistant.

6 Physical properties of soling and heels

6.1 Tensile requirements before ageing

Three test pieces shall be cut from both outsoles and heels, and shall then be reduced by careful buffing, or any other suitable method, to the thickness required by ISO 37, taking care to avoid an increase in temperature. The tensile strength and elongation at break of outsoles and heels shall then be determined by the method specified in ISO 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 the results.

All three test pieces shall be free from visible defects. If the median of the results is less than, and the highest value is greater than, the appropriate values given in table 1, two further test pieces shall be tested. The material shall be deemed not to comply with the requirements unless the median of five results is greater than the appropriate value.

Table 1 — Requirements for tensile strength and elongation at break

Footwear component	Minimum tensile strength, MPa*	Minimum elongation at break, %
Outsole	8,5	300
Heel	7,0	200

6.2 Tensile requirements after ageing

After ageing for 168 h at a temperature of 70 ± 1 °C in accordance with clause 3 of ISO 188, the changes in tensile strength and elongation at break of outsoles and heels, when determined as specified in 6.1, shall not exceed the values given in table 2.

Table 2 — Requirements for tensile strength and elongation at break after ageing

	Tensile strength, % of unaged value	Elongation at break, % of unaged value
Outsole	± 20	+ 10 − 30
Heel	± 20	+ 0 − 30

7 Soling — Minimum thickness

The minimum thickness of the soling shall be as specified in table 3.

Table 3 — Minimum thickness of soling

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 specified in annex C, shall be not greater than 150 000 Ω.

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 boot 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 188.

9.3 Flexing test

When tested by the method specified in annex B after having been submitted to the dry heat ageing test specified in 9.2, the uppers shall withstand not less than the number of continuous flexes specified 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 which are under tension during the

* 1 MPa = 1 MN/m².

test shall be observed, i.e. the folds which form a diamond shape. Pinholes or cracking associated with machine damage shall be ignored.

The test pieces shall be left for a minimum rest period of 2 days after having been subjected to the dry heat ageing test specified in 9.2.

The test equipment shall 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;

and, in addition, shall have a red back strip, together with a red rubber label bearing the words "Electrically conducting" affixed in a suitable position. The words "Test regularly" shall appear on each article on or near the label.

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 and weft directions, and shall 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, the test pieces shall be tested for breaking strength in both the warp and weft directions by the method specified in ISO 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 coated fabric above 0,5 kg/m².

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

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

Annex B

Method of testing resistance to flexing

B.1 Apparatus

The apparatus used shall comply with the following essential requirements.

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 duration 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 specified in ISO 471 and the temperature used shall be stated in the test report.

Annex C

Method of test for electrically conducting footwear

C.1 Apparatus

The test should preferably be carried out 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.

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

The instrument shall have 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.

Insulation 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 case of dispute, the voltage applied to the test piece shall be not less than 40 V.

C.2 Liquid electrodes and contacts

Liquid electrodes shall be formed on the surface of the boot 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
- potassium chloride: 10 parts

The electrode area shall be completely wetted and shall 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.

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

C.3 Procedure

Connect a clean zinc plate to the earth terminal of the measuring instrument. Apply liquid electrodes, 25 mm × 25 mm, to the insole of the boot and between the sole and the zinc plate. The test areas shall be so located that the results represent the electrical resistance of the normal discharge path. The resistance reading shall be taken 5 s after the voltage has been applied.

Measure the electrical resistance of the sole and heel independently.

The liquid electrodes may be conveniently applied by using open-weave fabric saturated with the conducting fluid. Alternatively, combined electrodes consisting of a metal electrode enclosed in a moistened pad may be used in place of the metal electrode / liquid system.

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