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

Textile floor coverings — Assessment of static electrical propensity — "Walking" test

This Technical Report, after having been prepared by a Working Group under ISO/TC 38/SC 12, *Textile floor coverings*, was approved by the sub-committee in a postal ballot in July 1979, thirteen P-members voting in favour and two against. The comments received were reviewed at the seventh meeting of ISO/TC 38/SC 12 in October 1980, where it was agreed that the amended text should be submitted to ISO/TC 38 for a postal ballot. This was carried out in March 1981, where twelve P-members of ISO/TC 38 voted in favour and one against.

The subject of static electrical propensity has been studied for a number of years in a Working Group of ISO/TC 38/SC 12 and, although the "Walking" test method has been refined during this period, the fourth draft proposal did not receive sufficient support for further processing as a draft International Standard. Nevertheless, many members of the Working Group felt that the method was of such importance and already so widely used that some form of official international publication was essential, whatever its shortcomings.

Contents

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0 Introduction

The present method of test for assessing the static electrical propensity of textile floor coverings has been prepared following extensive development work and laboratory trials. There are several reasons why a full International Standard was not produced, and these include the following :

— the variations in test results between laboratories, within laboratories and between operatives where shown to be high in a number of inter-laboratory trials; the reasons for such variations were not yet fully understood and were still being studied;

— the sensitivity of the method to changes in atmospheric conditions is very high, and the maintenance of these conditions within the prescribed limits is not easily achieved;

— experience of the method using two of the three sole materials is very restricted, and more information on the relationship of all three materials is required;

— new proposals concerning an alternative or additional mode of walking, and a different manner of recording the results, have been put forward and need evaluating alongside the existing method; details of these proposals are given below :

Scuffing walk

Instead of the procedure described in 9.2 which requires that the sandals be lifted to between 50 and 80 mm above the specimen, the following method is proposed : "Walk on the specimen, at the rate of 2 steps per second, rubbing the sandals on the specimen without lifting the feet, so that the sandals are always in contact with the specimen; when the walker has reached the end of the specimen, he turns in one place and moves over the specimen in the opposite direction. Come no closer than 50 cm to walls of the conditioning room and to other objects in it. Cover as much of the specimen as possible. When the peak voltage ceases to rise, continue walking for at least 30 s." The proponents of this method claim better reproducibility and higher voltages giving more discrimination, its critics comment on the lack of supporting background evidence, whilst several Working Group members see an advantage in including both walking methods in the test procedure.

Expression of results

Instead of the existing clause 10, the following procedure is proposed : "Determine from the recorder diagram the linear mean of the five highest peaks and valleys and express the result in kilovolts." The supporters of this alteration point out that the method is independent of the response time of the recording instrument; its critics claim that it is less reproducible and more dependent on the manner of walking.

These two variations are put forward for information in the hope that they will be studied in conjunction with the basic test method with a view to further consideration at a later date.

1 Scope and field of application

This Technical Report describes a "Walking" test method for the determination of the electrostatic propensity of textile floor coverings of all types.

2 References

ISO 48, *Vulcanized rubbers — Determination of hardness (Hardness between* 30 *and* 85 IRHD*).*

ISO/R 275, *Zinc oxide for paints.*

ISO 1957, *Machine-made textile floor coverings — Sampling and cutting specimens for physical tests.*

ISO 2781, *Rubber, vulcanized — Determination of density.*

ISO 3844, *Shoe sizes — Method of marking.*

3 Principle

The body voltage generated when a person wearing standardized footwear walks on the textile floor covering under controlled atmospheric conditions is measured.

4 Apparatus

4.1 Grounded metal base plate, measuring at least 200 cm × 100 cm.

NOTE — The use of an earthed metal plate on the floor of the test room or, alternatively, a floor which is entirely of metal may constitute a hazard where mains voltages are present. It is recommended that mains voltage sources in the test room be protected by the use of suitable earth leakage circuit breakers.

4.2 Rubber mat, of dimensions 220 cm × 120 cm, thickness 4,5 ± 0,5 mm and vertical resistance ⩾ 10^{12} Ω, in relation to a surface area of 1 cm^2.

NOTE — Determination of resistance value is not in practice carried out over an area of 1 cm^2.

4.3 Sandals, made in accordance with the requirements in annex A, and reserved specifically for this test method. At least two sole materials shall be used, conductive "BAM" rubber and either polyvinylchloride (PVC) or XS-664P Neolite in accordance with the requirements in annex B. The resistance between the metal plate and an operative standing on it wearing the sandals with conductive rubber soles shall be ⩽ 10^9 Ω, determined in accordance with the method in annex C; with the Neolite soles it shall be approximately 1,5 × 10^{10} Ω.

4.4 Means of cleaning the footwear :

4.4.1 Fine sandpaper.

4.4.2 Scoured cotton cloth, free from finish or detergent.

4.5 Ionizing source.

NOTE — Care should be taken if the ionizing source is of the polonium-210 type, which is toxic although not emitting harmful radiation.

4.6 Body voltage measuring system, consisting of a d.c. static voltmeter, an autographic recorder and a hand electrode, meeting the following requirements :

a) input resistance of voltmeter and hand electrode system : ⩾ 10^{14} Ω

b) input capacitance of hand electrode : ⩽ 20 pF

c) response time of whole system (electrode/voltmeter/recorder) such that the full-scale deflection on the recorder is reached within 0,25 s.

NOTE — Over-damping prevents true maximum voltage being observed; under-damping may cause overshooting. The system should be checked periodically against high and low voltage sources applied at step frequency.

An example of a suitable hand electrode system is given in annex D.

4.7 Wet-and-dry bulb ventilated hygrometer, capable of determining relative humidity to an accuracy of 1 %.

5 Atmosphere for conditioning and testing

The specimens shall be conditioned and the test conducted in an atmosphere of 23 ± 1 °C and 25 % ± 2 % relative humidity.

NOTE — It is important to maintain the atmosphere of the test room within the stated limits of temperature and humidity, as under controlled conditions in the region of 23 °C and 25 % r.h., variations in humidity of up to 2 % *can* produce changes in body voltage of up to 20 %.

6 Sampling and selection of specimens

Carry out sampling and selection of specimens in accordance with ISO 1957. From each sample, select at least one specimen, measuring 200 cm × 100 cm.

NOTES

1 In addition to the specimen, it is desirable to have standard specimens of known electrostatic propensity (if possible, one high charging and one low charging) in order to check the equipment and performance at regular intervals.

2 Generally, the test is carried out on the textile floor covering as received, i.e. with finishes and special treatments as appropriate. However, if it is required to investigate the permanency of such finishes and treatments, then it may be necessary to submit the specimen to a cleaning process or to practical wear conditions before testing. If so, these pre-treatments should be recorded in the test report.

7 Conditioning of specimens, rubber mat and sandals

Condition the specimens from the wet side in the atmosphere specified in clause 5 for at least 4 days, hanging them freely on a sample rack.

NOTE — Care should be taken to ensure that specimens are adequately conditioned, particularly in cases where certain special finishes are used, which can lead to slow conditioning.

The sandals (4.3), which should not be used for any other purpose, and the rubber mat (4.2) should remain in the testing atmosphere all the time if possible, but should nevertheless be conditioned in that atmosphere for at least 2 days.

8 Selection of operatives

The test should be conducted by one representative operative of either sex. Select this operatve and a replacement initially from a greater population consisting of 10 or more persons, by means of the "Walking" test. The two who produce body voltages nearest to the average body voltage from that population shall be considered as the representative operatives.

9 Test procedure

9.1 Preparatory

9.1.1 Cleaning of the footwear

9.1.1.1 Before each test series, and if testing is interrupted for a relatively long period of time, clean the soles, of all types, with fine sandpaper (4.4.1), and rub with a dry piece of scoured cotton cloth (4.4.2).

NOTE — A test series is defined as three (or more) tests on the same specimen with the same sole material.

9.1.1.2 Before each separate test, clean the soles in the manner most appropriate to the sole material (see the note), ensuring that the soles are dry before testing.

NOTE — The following are the methods recommended by the respective sole material suppliers :

- conductive "BAM" rubber : scoured cotton cloth, moistened with distilled or de-ionized water free from residual detergent;
- PVC : scoured cotton cloth, moistened with distilled or de-ionized water and drying in hot air;
- XS-644P Neolite : isopropanol solvent.

9.1.2 Discharging

Eliminate any residual static charge on the test materials using the ionizing source (4.5). Treat the rubber mat (4.2) in its operating position on the metal base plate (4.1), and the specimen, both front and back, whilst it is hanging in a vertical position. Then carefully lay the specimen without friction on the rubber mat, ensuring that it does not come into contact with the metal base plate.

Before each separate test, it is imperative that the operative, the footwear, the specimen and the measuring equipment are free of charge.

9.1.3 Determination of exact testing atmosphere

Determine and record the exact testing atmosphere immediately before and immediately after each test series, using for determination of relative humidity the hygrometer (4.7).

9.2 Performance of test

Place the sandals (4.3) with the conductive "BAM" rubber soles on the specimen. Step into the sandals, fasten them securely, take the hand electrode, already connected with the static measuring instrument (4.6), and ground oneself in order to start from zero voltage.

Walk on the specimen, at the rate of 2 steps per second, forwards and backwards, but always with the body facing the same direction. Avoid scuffing or pivoting, and at each step lift the sandals to between 50 and 80 mm above the specimen. Lift and lower the sandal sole in a plane parallel to the specimen. Come no closer than 50 cm to the walls of the conditioning room and to other objects in it. Cover as much of the specimen as possible and continue walking until the peak voltage ceases to rise, but for not more than 60 s.

Clean the soles in accordance with 9.1.1.2, and repeat the procedure in 9.1.2 and 9.2 at least twice more on the specimen, to complete the series of at least three tests with the same sole material on the specimen. Then carry out the second series of tests, beginning at 9.1, in the same way, but using the second sole material.

NOTES

1 Specimens used in previous tests, and therefore possibly charged, should be stored in such a way that they exert no disturbing effect on the test being carried out.

2 The rubber mat need not be used if it is specified that the textile floor covering is to be stuck down on concrete or on any surface having a resistivity to earth greater than $2 \times 10^9\ \Omega \cdot cm^2$.

10 Calculation and expression of results

Determine from the recorder diagram the median of the five highest valleys (the "two feet median") and express the result, in kilovolts, to the nearest 0,1 kV.

11 Test report

The test report shall include the following information :

a) that the tests were performed in accordance with this Technical Report;

b) the identification of each sample, including type of pre-treatment (if any);

c) the number of specimens per sample;

d) the number of test series per specimen;

e) for each test series :

1) the type of sole material used, i.e. conductive "BAM" rubber and PVC or XS-644P Neolite,

2) the exact testing atmosphere,

3) the number of tests,

4) the individual body voltages, in kilovolts, to the nearest 0,1 kV,

5) the average body voltage, in kilovolts, to the nearest 0,1 kV;

f) the type of rubber of the mat;

g) details of any operations not included in this Technical Report or regarded as optional, or any deviations from the established procedure.

Annex A

Specification of the sandals[1)]

A.1 General

The sandals are Mondopoint size 270/100 (see ISO 3844), with open toe, adjustable heel and instep straps and an adjustable strap on the forepart. These straps are lasted to an insole to which a wedge heel is attached, and the whole is provided with an outer sole made in one piece. A complete sock lining is stuck to the insole.

A stainless steel plate is inserted centrally near the front, and aluminium rivets are inserted at both front and back to provide a conductive contact between outer sole and wearer (see figures 1 and 2). All rivets should have a good contact with either the outer sole or the steel plate at the bottom and with the foot at the top.

A.2 Lasts

The sandals are made on lasts with a good fit. The last bottom, called also the "insole model" should meet the requirements of the insole pattern in figure 1, which also gives the positioning of the steel plate and aluminium rivets.

The upper part of the lasts should be made so that footwear can be manufactured with a good fit for this specific purpose.

A.3 Materials

The materials required, which should be of good quality, are given in the table.

Table — Materials for the sandals

Material	Description
Upper leather	Full grain chrome tanned side leather, 1,5 to 1,6 mm thick
Lining leather	Fattened calf, 1,2 to 1,4 mm thick
Sock lining	Fattened calf, 0,7 mm thick
Insole leather	Leached good-year shoulder, 3,0 mm thick
Contact fastener tape ("Velcro" type)	3 cm wide
Stitching threads	R 75/3 tex
Wedge heels	Microcel rubber, hardness about 60 IRHD
Outer soles	a) Butt leather (allowing stitching and adhesive binding) b) Standardized sole material, see 4.3 and annex B
Adhesion used for :	
— lining attachment	Cement (rubber adhesive)
— sock lining	Polyvinyl acetate emulsion adhesive
— attachment of Velcro tape	Cement (rubber adhesive)
— cement lasting	Neoprene adhesive
— attachment of wedge heel	Neoprene adhesive
— sole attachment	Neoprene adhesive
Rivets	Blind aluminium rivets (flat-headed ± 9 mm diameter head) — front ϕ 4 mm × 7,4 mm with cadmium plate washer ϕ 4,2 mm × ϕ 9 mm × 0,6 mm — heel ϕ 4,8 mm × 25,4 mm with cadmium plate washer ϕ 5,2 mm × ϕ 12 mm × 0,7 mm

1) Sandals made to this specification are available from Vezelinstitut TNO, P.O. 110, Schoemakerstraat 97, Delft, Holland.

A.4 Construction

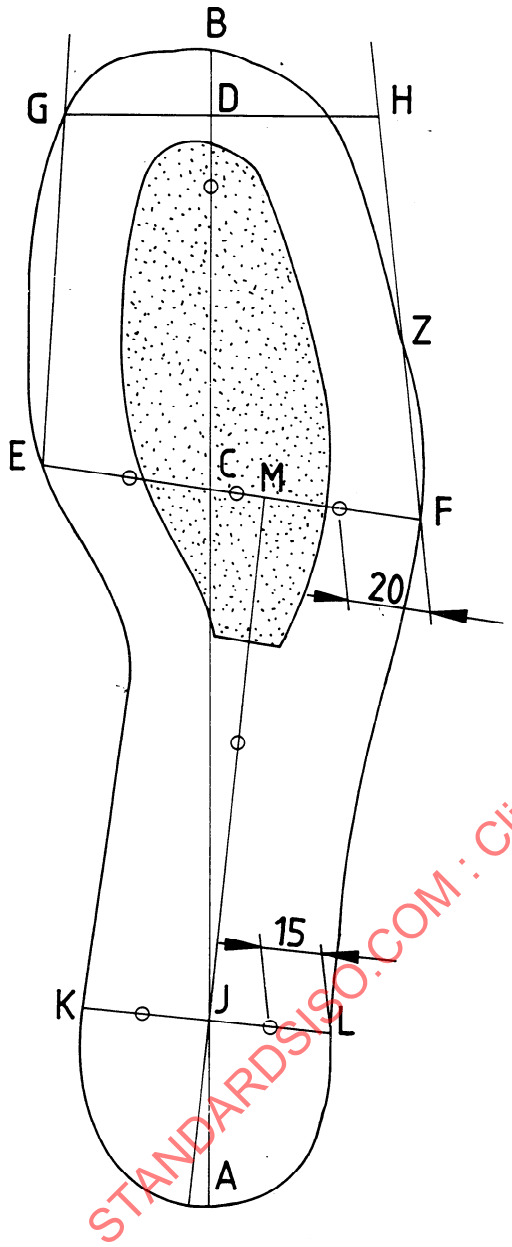
The upper is composed of four straps the positions of which should be such that the joint instep and heel of the foot are well enclosed. The straps are fastened by means of contact fastener tape (e.g. "Velcro") fixed to the straps , so that the sandals can be adapted to a wide range of foot sizes.

Attach the contact fastener tape to the straps by sticking and then secure it with a single row of stitching. Stick the upper leather and lining to one another in the fit of the last, in order to avoid creasing. Complete the uppers by trimming the straps and under edge and finishing all edges.

Press-cut the side of the insole to the right size, and paint it. Cement-last the upper to the insole, then roughen the lasting margin and insole and remove all dust so that a good base is formed for attaching the wedge and outer sole.

Attach the wedge heel to the lasted sandal, then stick the sock lining to the insole, since at this stage the steel plate and the aluminium rivets should be put into place. Clearly mark the positions on the sock lining where the steel plate and rivets are to be fitted. After attaching them, stick the sole under the sandal, and finish the edges.

NOTE — In order to ensure good contact, the heads of the aluminium rivets should not come into contact with the adhesive, either above or below. It is essential that there is direct contact between the foot and the aluminium rivets on one side and between the aluminium rivets and the outer sole or the steel plate on the other.



Dimensions in millimetres

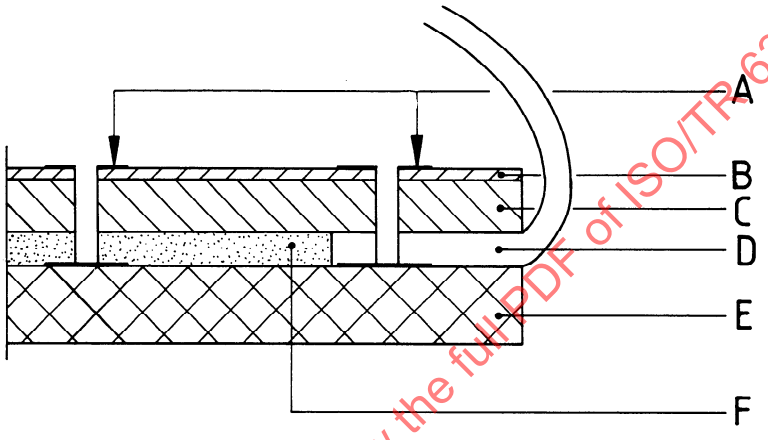
Line designation		Length of lines
AD	Length of the foot	273
BD	Normal allowance	15
AB	Length of last	288
AC	62 % of AB	179
BC	38 % of AB	109
EC	One-sixth of joint girth	42
FC	One-sixth of joint girth plus 26 % of one-sixth of joint girth	52
EF	Joint width	94
HZ	One-fifth of AD	55
EM	60 % of EF	56
AJ	One-sixth of AD	46
KJ	One-third of EF	31
LJ	One-third of EF	31
KL	Heel width	63

Scale approximately one-half lifesize

o Positions of the blind rivets

Stainless steel

Figure 1 — Insole pattern



A Hollow rivets
B Sock lining
C Insole
D Leather strap
E Outsole
F Stainless steel

Figure 2 — Positioning of blind rivets and steel plate

Annex B

Standard sole materials

NOTE — The details of composition and specification given in this annex have been provided by the manufacturers.

B.1 Conductive "BAM" rubber

B.1.1 Composition

Component	Parts in mass
Natural rubber average viscosity (80 ± 5) ML (1 + 4) (100 °C)	100,0
2,2′-Dibenzothiazyldisulphide	1,2
N-Isopropyl-*N*′-phenyl-*p*-phenylenediamine	1,0
Zinc oxide (Type 1 ISO/R 275)	50,0
HAF carbon black (ASTM N330)	36,0
Sulphur	2,5
Vulcanization at 150 °C for 30 min	

B.1.2 Specification

Property	Limits	Test method
Hardness (IRHD)	60 ± 3	ISO 48
Relative density	1,35 ± 0,02	ISO 2781
Vertical resistivity	10^8 to 10^9 Ω·cm^2	
Thickness	3,0 ± 0,5 mm	

B.1.3 Availability

The rubber can be obtained from :

Bundesanstalt für Materialprüfung
Unter den Eichen 87
D-1000 Berlin 45
West Germany

B.2 Polyvinyl chloride

B.2.1 Composition

Component	Parts in mass
Suspension PVC	100
Di(2-ethylhexyl) phthalate	60
Octyl epoxy stearate	4,0
Barium-cadmium-calcium-zinc stabilizer	1,5
Carbon black	0,25

B.2.2 Specification

Property	Limits
Hardness (IRHD)	79 ± 2
Relative density	1,23 ± 0,01
Thickness	3,25 ± 0,15 mm
Vertical resistivity	10^{11} to 10^{12} Ω·cm^2

B.2.3 Availability

The polyvinylchloride soles are manufactured by Aarslev Polymere Industri A/S and can be obtained from

Dansk Textil Institut
Gregersensvej 5
DK-2630 Taastrup
Denmark

B.3 Neolite — Standard XS-664P

NOTE — The standard XS-664P Neolite is only available from AATCC. The limited specification given below is reproduced by permission of Goodyear Tire and Rubber Company. The specification is expressed in terms of some ASTM test methods, which have not been converted here to ISO equivalents (if any).

B.3.1 Rubber specification

Standard cold nonoil extended styrene butadiene rubber, with fillers — wood fibre 10 %, aluminium magnesium silicate 25 %.

Processing additives zinc oxide, stearic acid, petroleum base resin, antioxidant, sulphur for vulcanization, and trace of colourants.

The exact formula is adjusted at each test to conform to the reference established by Goodyear in 1950.

B.3.2 Physical properties

Surface hardness	93 to 96 Durometer A
Relative density	1,23 ± 0,02
Thickness	3,18 mm
Vertical resistivity	> 5 × 10^{11} Ω·cm^2
NBS Abrasive Index	35 ± 4 (Method B of ASTM Methods D 394-47)
Elongation at break	375 % ± 25 %
Values checked at	23 ± 1,1 °C

B.3.3 Mounting procedure

The rubber should be attached to the bottom surface of the sandal with the rough side next to the sandal and the smooth side outermost as the wearing surface.

B.3.4 Availability

The Neolite can be obtained from :

AATCC Technical Center
P.O. Box 12215
Research Triangle Park
NC 27709
USA

Annex C

Method for measuring the electrical resistance of the footwear

The electrical resistance through the standard sandals may be determined while the operator, wearing the sandals, stands on a clean metal plate which is earthed. A suitable circuit is given below (figure 3) consisting of a d.c. voltage source, V, of not less than 100 V, a safety resistor, R_s, a current-measuring instrument with milli-, micro- and nanoampere ranges, and a switch. The value of the safety resistor should be such that with the d.c. voltage applied across it, the strength of the current is about 0,1 mA.

With the meter set to the milliampere range, the operator stands with both feet firmly on the metal plate and takes hold of a conducting electrode which is connected to the voltage source via the safety resistor. On closing the switch the current reading, I, is noted, adjusting the sensitivity of the ammeter as required.

Assuming Ohm's law, the resistance, R, through the footwear is given, in ohms, by the formula

$$R = \frac{V}{I} - R_s$$

Usually $R \gg R_s$, in which case

$$R \approx \frac{V}{I}$$

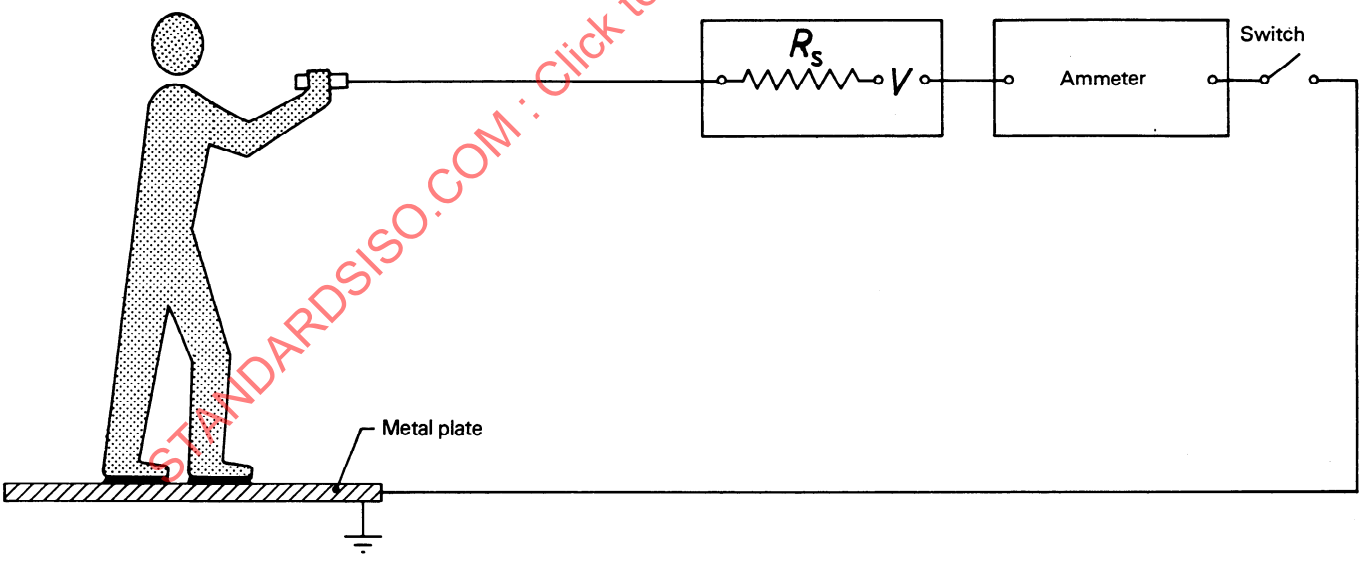


Figure 3 — Circuit for measuring the electrical resistance of the footwear