International Standard 4643

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Plastics moulded footwear — Polyvinyl chloride industrial boots — Specification

Chaussures moulées en plastique — Bottes industrielles en chlorure de polyvinyl — Spécifications

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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 4643 was developed by Technical Committee ISO/TC 45, *Rubber and rubber products*, and was circulated to the member bodies in April 1978.

It has been approved by the member bodies of the following countries :

Austria	Italy	Sweden
Belgium	Korea, Rep. of	Thailand
Brazil	Mexico	Turkey
Bulgaria	Netherlands	United Kingdom
Canada	Romania	USA
Czechoslovakia	South Africa, Rep. of	USSR
Egypt, Arab Rep. of	Spain	
France	Sri Lanka	

No member body expressed disapproval of the document.

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Plastics moulded footwear — Polyvinyl chloride industrial boots — Specification

1 Scope and field of application

This International Standard specifies the requirements for boots moulded from polyvinyl chloride compounds for general industrial use. They may be either fabric-lined or unlined.

It does not specify the style of boot, which may be of the high, medium, half or ankle types.

2 References

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

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

ISO 176, *Plastics — Determination of loss of plasticizers — Activated carbon method.*

ISO 458, *Plastics — Determination of stiffness in torsion as a function of temperature.*[1)]

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

3 Materials

3.1 PVC compound

The upper, soling and heel shall be moulded from homogeneously mixed polyvinyl chloride compounds which may contain other polymers in order to obtain specific properties appropriate to use.

3.2 Fabric

In the case of lined boots, the fabric shall be knitted and free from such defects as would detract from the serviceability of the finished product. When a boot is tested as described in annex A, the breaking force of the coated lining fabric shall comply with the requirements of table 1.

Table 1 — Breaking force of coated lining fabric

Component	Minimum breaking force, N	
	along the length of the material	along the breadth of the material
Coated knitted fabric	150	150

4 Design

4.1 Soling pattern

The soling shall not include continuous lateral tread patterns or any other features, such as unradiused corners at the base of the sole pattern, which may accelerate or cause premature crack formation.

4.2 Minimum boot height

The height shall be subject to agreement between purchaser and supplier, but it is recommended that the heights in table 2 be used.

Table 2 — Recommended minimum heights of boots

Type of boot	Recommended minimum heights*, mm,	
	men's boots	women's boots
High	330	280
Medium	240	205
Half	180	150
Ankle	115	115

* The height is measured on the inside at the back of the boot.

5 Minimum thicknesses

5.1 Upper

The thickness of polyvinyl chloride compound shall be not less than 1,00 mm at any point round the top circumference of the boot upper excluding the raised top edge reinforcement, and not less than 3,00 mm at any point on the lowest part of the upper adjacent to the soling or heel join.

1) At present at the stage of draft. (Revision of ISO/R 458-1965.)

5.2 Soling and heel

5.2.1 Requirements

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

Table 3 — Minimum thickness of soling and heel

Component	Minimum thickness, mm
Cleated soling (men's boots)	13
Cleated soling (women's boots)	11
Cleated heel	25

NOTE — The above figures may include filler up to 4 mm.

5.2.2 Method of measurement

The boot shall be slit through the centre of the soling longitudinally and perpendicular to the surface. The thickness of the soling and heel over any pattern shall be measured at three widely separated points along the cut, two on the soling and one at the back of the heel.

6 Physical properties

6.1 Hardness

The hardness of the material, measured after not less than 7 days, but not more than 90 days, after moulding, and determined in accordance with ISO 48 at 23 ± 2 °C after conditioning at that temperature for not less than 3 h, shall comply with the requirements of table 4.

Table 4 — Hardness of polyvinyl chloride compound

Component	Hardness, IRHD	
	minimum	maximum
Upper	42	55
Soling and heel	50	64

6.2 Volatility

When tested in accordance with ISO 176 at a temperature of 100 ± 1 °C for 24 h, the loss in mass of samples of the polyvinyl chloride compound taken from the upper and soling and heel components of the boot shall not exceed 1,6 %.

6.3 Tensile requirements

The stress at 100 % elongation, and the elongation at break, of the upper and the soling shall be determined according to the method described in ISO 37, using dumb-bell test pieces taken from products. A smaller dumb-bell test piece may be used if size makes this necessary, but in this case the size of the dumb-bell shall be stated when expressing results.

Five test pieces shall be used for each test and the median value of each group of five test results shall be in accordance with table 5.

In the elongation at break test, if the median value is below, and the highest value is above, the appropriate value given in table 5, five further test pieces shall be tested. The material shall be deemed to comply with the requirements of this International Standard only if the median of all ten results is not below the appropriate value.

In the test for stress at 100 % elongation, if the median of the results is outside, but some results are inside, the appropriate range specified in table 5, five further test pieces shall be tested. The material shall be deemed to comply with the requirements of this International Standard only if the median of all ten results is within the appropriate range.

In the case of a lined boot, the lining may be removed before carrying out the test. This may be achieved by the careful use of a minimum amount of suitable solvent, such as methyl ethyl ketone, or a leather splitting machine.

Table 5 — Tensile properties

Component	Stress at 100 % elongation MPa	Minimum elongation at break %
Upper	2,5 ± 1,25	300
Soling	3,25 ± 1,25	300

6.4 Soling — Resistance to cut growth (flexing test)

When parts of the soling are tested in accordance with the method described in annex B, at a temperature of −5 ± 2 °C, the minimum number of flex cycles to achieve 6 mm cut growth (8 mm crack) shall be 150 000.

6.5 Upper — Resistance to flexing

When parts of the upper are tested in accordance with the method described in annex C, at a temperature of −5 ± 2 °C, no cracking shall occur during 150 000 flex cycles.

6.6 Cold flex temperature

When parts of the upper are tested in accordance with the method described in ISO 458, applied as indicated below, the cold flex temperature shall not be above −25 °C.

A graph shall be prepared showing the relationship between deflection and temperature, and from this the temperature at which the deflection is 200° shall be determined. A deduction of 0,5 °C shall be made for each 0,03 mm of the thickness of the test piece above 1,30 mm, and an addition of 0,5 °C for each 0,03 mm of thickness below 1,27 mm.

The arithmetic mean of two results shall be recorded as the cold flex temperature of the material under test.

7 Marking

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

a) size;

b) manufacturer's or supplier's identification;

c) number of this International Standard.

Annex A

Method of preparation and test for coated fabrics

Cut two strip test pieces of rectangular shape, 25 mm wide, from the upper part of the boot to be tested. These shall cover both length and breadth directions, 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 test piece to be cut giving a free length of 75 mm between the jaws, a free length of 25 mm shall be used.

These test pieces shall be tested for breaking force of the fabric in both length and breadth directions in accordance with the requirements of ISO 1421, except as indicated below.

Set the test jaws at 75 mm or 25 mm apart, as appropriate.

The breaking force shall be expressed in newtons, N, in the length and breadth directions for a test piece 25 mm in width.

Annex B

Resistance to cut growth (flexing test)

B.1 Principle

This test gives a measure of the resistance of soling material to cracking resulting from flexing in wear. The material is repeatedly flexed through 90° over a mandrel after a small cut has been made right through it with a chisel. The rate of growth of this cut is a measure of the tendency of the material to crack.

B.2 Apparatus

B.2.1 Flexing machine[1] (Satra Ross type), having a flexing mechanism as shown in figures 1 a) and 1 b).

The test piece A is inserted against the end stop of the flexing arm B and held by the clamp C in which length JK is 50 ± 5 mm. The other end of the test piece is not clamped but moves in and out between rollers D, E and F as the test piece is flexed. The flexing takes place round mandrel H which has a radius of curvature of 5,0 ± 0,3 mm.

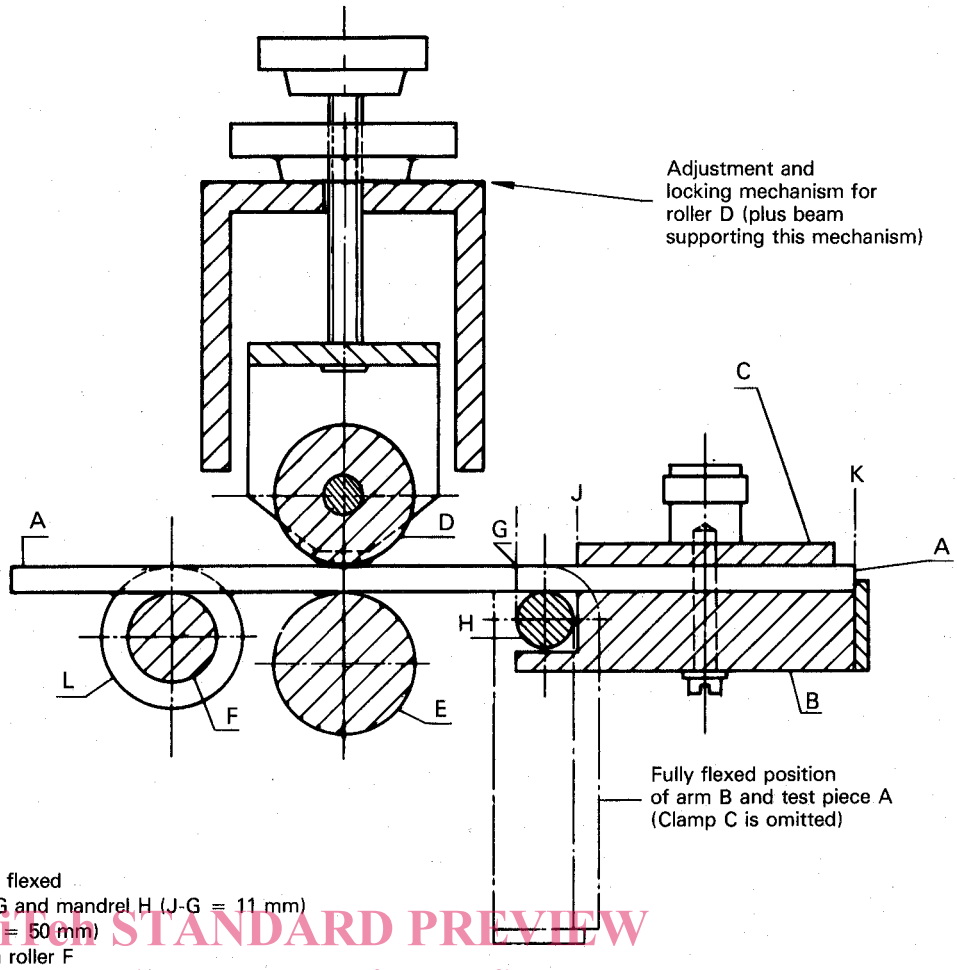
The distance in plan between the vertical tangent to this mandrel through point G and the adjacent edge J of clamp C is 11,0 ± 0,5 mm. The chisel cut previously made in the test piece, is positioned vertically above the edge of the mandrel when the test piece is in the unflexed position, i.e., at point G in figure 1.

The tops of rollers E and F and mandrel H are in the same horizontal plane and roller D is vertically above roller E. Except for this, the dimensions and positions of rollers D, E and F are not critical. A suitable diameter for rollers D and E is 25 mm and for roller F is 10 mm or 15 mm. A suitable distance in plan between the centres of rollers D and E and the centre of curvature of mandrel H is 30 mm, and between the centres of rollers D and E and the centre of roller F is 25 mm or 30 mm. The vertical position of roller D is adjustable so that the gap between this and roller E can accommodate test pieces of various thicknesses. A locking mechanism is provided to ensure that the gap cannot change during a test.

Roller F has two adjustable collars L. Their purpose is to help to position the unclamped end of the test piece during insertion in the apparatus, so that the test piece is at right-angles to the flexing mandrel in plan, and to guide it in that position during flexing. The difference between the internal and external diameter of each collar should be about 10 mm. For the standard test piece, the distance between the collars should be from 25,5 mm to 26,0 mm.

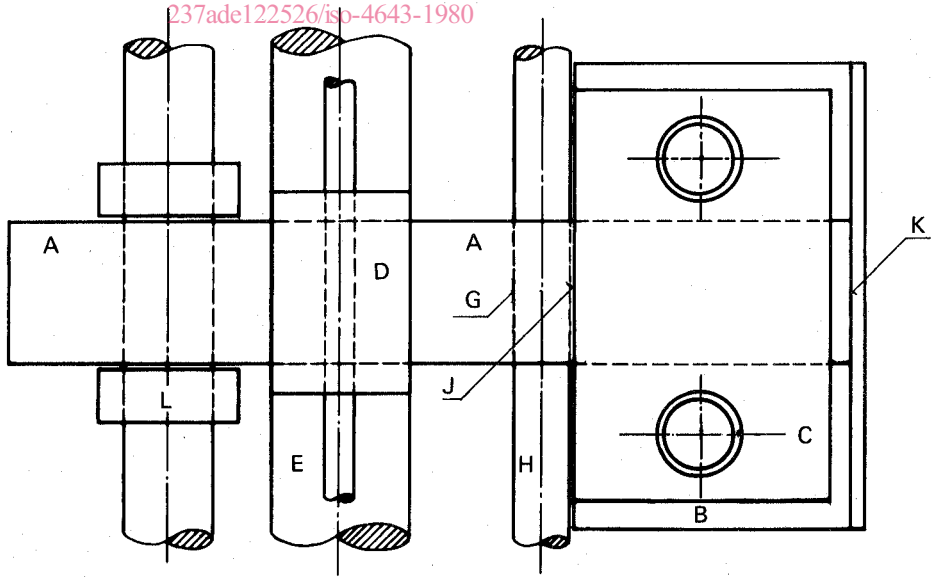
The frequency of flexing shall be 1,0 ± 0,1 Hz.

1) Details of sources of supply of commercially available equipment may be obtained from the Secretariat of ISO/TC 45 (BSI).



A : Test piece
B : Flexing arm
C : Test piece clamp
D : Adjustable upper guide roller
E : Lower guide roller
F : Rear guide roller
G : Chisel cut inserted in test piece
H : Mandrel round which test piece is flexed
J : Edge of clamp C adjacent to cut G and mandrel H (J-G = 11 mm)
K : Position of end of test piece (J-K = 50 mm)
L : Positioning collar for test piece on roller F

a) Side view of test piece, flexing arm, and guide rollers



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L : Positioning collar for test piece on roller F

b) Plan view of test piece, flexing arm and guide rollers

NOTE — For clarity, the adjustment and locking mechanism for roller D [shown in figure 1 a)] has been omitted.

Figure 1 — Flexing machine

B.2.2 Refrigerated cabinet, capable of being maintained at −5 ± 2 °C. The driving motor of the flexing machine shall be outside the cabinet.

B.2.3 Piercing chisel, to produce the initial cut in the test pieces, as illustrated in figure 2. The cutting edge is 2 mm long but it is usual for the length of cut produced in the material to differ a little from this. The insertion of the cut in the correct position is made easier by holding the chisel in a cutting jig.

B.3 Preparation of test pieces

The standard test piece is 25 mm wide by 150 mm long, and the standard thicknesses are 3,0 — 5,0 — 7,0 — 10,0 and 15,0 mm. Test three pieces from the soling material. Remove any pattern and reduce the thickness of the test pieces to a standard thickness by cutting and very light buffing of both sides of the test piece. Pierce each test piece approximately 60 mm from one end, so that the length of the cut is symmetrical across the centre line of the test piece. The chisel shall penetrate right through the test piece and protrude 15 mm on the other side, except for test pieces 10,0 and 15,0 mm thick when a depth of cut of 7,5 mm is allowable. An adjustable collar may be fitted to the chisel shank to control the penetration distance of the chisel.

B.4 Conditioning and temperature of test

Condition the test pieces for 24 h at 23 ± 2 °C, and test at a temperature of −5 ± 2 °C. The test shall not normally be carried out less than 7 days, or more than 3 months, after moulding.

B.5 Procedure

Make a preliminary check of the rate of flexing of the machine to ensure that it runs at the correct speed.

Measure and record the initial length of the cut in each test piece to an accuracy of 0,3 mm. This may most conveniently be done by using a magnifying eyepiece and scale with the test piece bent through 45° round a 15 mm diameter mandrel.

Turn the drive wheel of the flexing machine manually until the flexing arm B is horizontal. Raise the top roller D by slackening the knurled knobs which secure the top frame of the machine. Slacken each clamping plate C. Insert each test piece, wearing surface uppermost, from the back of the machine (the flexing arm B is assumed to be at the front) so that it passes between rollers D and E and then between the clamp C and flexing arm B and abuts against the end stop of B. Roller F and the flexing arm B are both recessed so as to assist in positioning the strip test pieces. Clamp C holds two test pieces, one on each side of the centre screw which fixes it to arm B. Check that the cut in each test piece is vertically above the edge of mandrel G, then tighten clamp C, making sure that it is parallel to the edge of the flexing arm. Should only one test piece be held in a particular clamp, insert a small piece of the same material in the recess on the other side of the clamp so that the surface of the clamp remains parallel to the surface of the flexing area when it is tightened. Screw down roller D so that it just touches, but does not grip, the test piece. Lock this roller by tightening the wing-nut, which is on the same screw thread, against the frame of the machine.

NOTE — Flexing should commence immediately the test piece is mounted, since the test pieces will always be at a higher running temperature than the cabinet because of heating by flexing, and it has been found better for the test piece to cool to this running temperature during the initial part of this test than for it to start colder, and then warm up.

After the flexing has been started, inspect the test pieces at frequent intervals (say every hour initially) for evidence of any increase in length of the initial cut, or of new cracks forming.

To do this, remove all the test pieces from the cabinet, measure the crack lengths after bending through 45° round a 15 mm mandrel, and then replace all the test pieces as described under the initial loading procedure.

If for any reason flexing is discontinued, remove the test pieces from the machine.

Flexing should be continued until either

a) the initial cut has increased by 6 mm or more, or

b) until the test pieces have flexed for the specified number of cycles without the initial cut increasing in length by 6 mm.

In case a), it is usually impossible to observe the number of flexes when the amount of cut growth is exactly 6 mm but it should be possible to make observations when it is a little less and a little more than this value. The number of flexes for 6 mm growth can then be obtained by interpolation either graphically or arithmetically.

In case b), measure the length of the crack after the specified number of cycles and calculate the amount of cut growth.

B.6 Expression of results

If the end point of the test is reached before the specified number of cycles, express the result as the number of cycles for the cut to increase in length by 6 mm.

If the test reached the specified number of cycles (i.e. the cut did not increase in length by 6 mm after this number of flexes), express the result as the increase in cut length after the specified number of cycles.

Record the temperature of test.