IS 9766 (1992): Flexible PVC Compounds [PCD 12: Plastics]

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(Reaffirmed 2003)

भारतीय मानक

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(पहला पुनरीक्षण)

Indian Standard

FLEXIBLE PVC COMPOUNDS — SPECIFICATION

(First Revision)

UDC 678·743·22

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

Flexible polyvinyl chloride (PVC) compounds consisting of PVC or a copolymer of vinyl chloride or both, suitably compounded with plasticizers and other ingredients are available over a wide range of hardness and flexibility. PVC is made suitable for numerous applications by varying type and quantity of plasticizers. General properties, common to all members of PVC group, include excellent water and chemical resistance, strength, abrasion resistance and unlimited colour possibilities ranging from crystal clear to black opaque. This accounts for the use of PVC for numerous applications which include film, coating, floor tiles, household products, gramophone rocords, gloves, hoses, etc.

This standard was first published in 1981. Subsequently the Committee felt that this standard needed revision in view of the fact flexible PVC compounds are predominantly used for cables, footwear and tubes and films. And it was decided to revise the existing classes and types of flexible PVC compounds along with their requirements. Accordingly, the material has been reclassified into two classes, namely Class I — Flexible PVC compounds for electrical wires and cables, and Class II — Flexible PVC compounds for all end uses except electrical.

Each class has been further subdivided into a number of types separately in accordance with properties. Additional characteristics have been included and requirements suitably modified for the classes and types of materials. Properties of Class I has been specifically designed to meet the requirements of IS 5831 : 1984 'PVC Insulation and sheath of electric cables (*first revision*)'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

FLEXIBLE PVC COMPOUNDS — SPECIFICATION

(First Revision)

1 SCOPE

This standard prescribes the requirements, methods of sampling and tests for flexible polyvinyl chloride compounds.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
196 : 1966	Atmospheric conditions for testing
285 : 1974	Laundry soaps
686 : 1985	Methods for determination of colour fastness of textile materials to daylight
768 : 1982	Method for evaluating change in colour
2405 (Part 1) : 1980	Industrial sieves : Part 1 Wire cloth sieves (*first revision*)
2828 : 1964	Glossary of terms used in plastics industry
3396 : 1979	Methods of test for volume and surface resistivity of solid electrical insulating materials
4905 : 1968	Methods for random sampling
8543 (Part 4/ Sec 1) : 1984	Methods of testing plastics : Part 4 Short term mechanical properties, Section 1 Determination of tensile properties
10151 : 1992	Polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
13360 (Part 2/ Sec 1) : 1992	Plastics — Methods of testing : Part 2 Sampling and preparation of test specimens, Sec 1 Compression moulding test specimens of thermoplastic materials
13360 (Part 5/ Sec 11) : 1992	Plastics — Methods of testing : Part 5 Mechanical properties, Sec 11 Determination of indentation hardness of plastics by means of durometer (shore hardness)

2.1.1 The above Indian Standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated above.

3 TERMINOLOGY

3.1 For the purpose of this standard, definitions given in IS 2828 : 1964 and the following shall apply.

3.1.1 *Flexible Polyvinyl Chloride Compound*

A compound suitable for extrusion, injection moulding and compression moulding and consisting of polyvinyl chloride, and/or a copolymer of vinyl chloride, suitably compounded with plasticizers and other ingredients.

4 CLASSES AND TYPES

4.1 The material shall be of the following two classes:

Class I — Compounds having specified electrical properties and having a volume resistivity not less than 1013 ohm-cm at 27°C with respect to 500 ± 50 VDC.

Class II — Compounds for other applications like shoes, tubes, hoses, etc and for electrical applications excluding wires and cables.

4.2 Types

Each class is further subdivided in accordance with its properties, into a number of types as shown in Tables 1 and 2.

5 REQUIREMENTS

5.1 Form

The compound shall be in the form of random cut chips, regular cubes, regular cylindrical pellets, powder or any other convenient form.

5.2 Appearance

The compound shall be free from foreign matter and uniform in colour. It may be of any colour. The colour of the sheet moulded in accordance with Annex A and IS 13360 (Part 2/Sec 1) : 1992 shall be taken as the colour of the compound.

5.3 Colour Stability

5.3.1 *Fastness to Daylight Exposure*

The colour fastness shall be rated at not less than standard 4 when the pigmented compound is tested in accordance with the method described in Annex B.

5.3.2 *Colour Bleeding*

There shall be no staining or marking of the sheet or of the filter paper when the pigmented compound is tested in accordance with the method described in Annex C.

5.4 Physical and Other Properties

When the compound is tested in accordance with the appropriate Annexes, the results of each type of compound shall fulfil the appropriate requirements as follows:

Class I — Table 1
Class II — Table 2

Table 1 Requirements for Class I Flexible PVC Compounds for Electrical Wires and Cables

(*Clause* 5.4)

Sl No.	Characteristic	Unit	Requirement for Type					Method of Test, Reference to IS/Annex
			A	B	C	ST1	ST2	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Durometer hardness, *Min*	Shore A	80	90	90	80	80	13360 (Part 5/Sec 11) : 1992
ii)	a) Tensile strength, *Min*	N/mm^2	15.0	15.0	15.0	15.0	15.0	8543 (Part 4/Sec 1) : 1984
	b) Elongation, *Min*	%	175	150	150	175	175	do
iii)	After ageing in air oven :							
	a) Treatment							
	Temperature	°C	80	100	135	80	100	D
	Duration	days	7	7	7	7	7	—
	b) Tensile strength :							
	i) Value after ageing, *Min*	N/mm^2	15.0	15.0	15.0	15.0	15.0	8543 (Part 4/Sec 1) : 1984
	ii) Variation, *Max*	%	± 20	± 25	± 25	± 20	± 25	
	c) Elongation at break :							
	i) Value after ageing, *Min*		175	150	150	175	175	8543 (Part 4/Sec 1) : 1984
	ii) Variation, *Max*	%	± 20	± 25	± 25	± 20	± 25	
iv)	Volume resistivity (V.R.), *Min* :	ohm-cm						
	i) V.R. at 27°C		5.0×10^{13}	5.0×10^{14}	5.0×10^{13}	—	—	E
	ii) V.R. at 70°C		5.0×10^{10}	5.0×10^{11}	—	—	—	—
	iii) V.R. at 80°C		—	—	5.0×10^{10}	—	—	—
v)	Loss of mass in air oven :							
	a) Treatment							
	Temperature	°C	80	100	135	80	100	
	Duration	days	7	7	7	7	7	F
	b) Loss of mass, *Max*	mg/cm^2	2	2	2	2	2	
vi)	Thermal stability at 200°C time, *Min*	minutes	120	140	140	60	120	5831 : 1984 Annex B
vii)	Cold bend temperature at which sample does not crack	°C *Min*	−20	−10	−20	−20	−20	G

Table 2 Requirements for Class II Flexible PVC Compounds for Type *n*

(*Clause* 5.4)

Sl No.	Characteristic	Unit	Requirement for Type						Method of Test, Reference to IS/Annex
			D	E	F	G	H	I	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Durometer hardness	Shore A	50 *min*	51-60 *min*	61-70 *min*	71-80 *min*	81-90 *min*	90 *min*	13360 (Part 5/ Sec 11) : 1992
ii)	Tensile strength, *Min*	N/mm^2	6	8	10	12	15	15	8543 (Part 4/ Sec 1) : 1984
iii)	Elongation at break, *Min*	%	200	200	175	175	175	150	do
iv)	Volatile loss at 130°C/3 h, *Max*	%	2.0	2.0	1.5	1.5	1.0	1.0	H
v)	Cold bend temperature at which sample does not crack, *Min*		−20	−20	−20	−20	−20	−10	G
vi)	Volume resistivity at 27°C, *Min*	Ohm-cm	–	–	–	1×10^{11}	1×10^{12}	1×10^{13}	E
vii)	Ageing :								
	a) Treatment								
	Temperature	°C	← 80°C →						D
	Duration	days	← 7 →						
	b) Tensile strength, Variation, *Max*	%	← ± 20% of the individual value before ageing →						8543 (Part 4/ Sec 1) : 1984
	c) Elongation at break, Variation, *Max*	%	← ± 20% of the individual values before ageing →						do

5.5 Contact with Foodstuffs, Pharmaceuticals and Drinking Water

When the products (Class II) are used in contact with foodstuffs, pharmaceuticals and drinking water, its requirements with respect to material shall also be met as per IS 10151 : 1982.

6 PACKAGING AND MARKING

6.1 Packing

The material shall be packed in suitable bags as agreed between the purchaser and the supplier.

6.2 Marking

The bags shall be marked with the following information:

a) Mass of the material;
b) Indication of the source of the manufacture and trade-mark, if any;
c) Class and type of material;
d) Batch number; and
e) Month and year of manufacture.

6.2.1 The bags may also be marked with the Standard Mark.

7 SAMPLING

Representative samples of the material shall be drawn as prescribed in Annex J.

ANNEX A

(*Clause* 5.2)

PREPARATION OF MOULDED TEST SPECIMENS FROM FLEXIBLE PVC COMPOUNDS

A-0 The properties of a moulded article depend, amongst other things, on the composition of the moulding material, the shape and the state of anisotropy of the moulding, and on the methods of test used. Preparation of moulded sheet and blocks involves a preparation of a rough sheet from the material to be tested, using a heated two roll mill. The preliminary sheets are subsequently compression moulded to produce sheets of uniform thickness. Test specimens are prepared from these moulded sheets by machining or die-cutting.

A-1 PREPARATION OF PRELIMINARY SHEETS

A-1.1 Apparatus

Two roll mill capable of operating satisfactorily at temperature up to and including 180°C:

a) The rolls shall be cylindrical;

b) The surface speed of the rolls shall be approx 10 m/min ; and

c) Rolls shall have differential speed between the two rolls. The preferred ratio is 1:1·2 to 1:1·4, the front (working) roll being the slower.

A-1.2 Milling Conditions

A-1.2.1 The surface temperature of the mill rolls and the moulding temperature used subsequently shall be based on the shore hardness of the material in accordance with the following table:

Shore Hardness	*Surface Temperature °C (± 5 °C)*	
Scale value	Rolls	Moulds
A up to 80	130 to 160	135 to 170
A 80	145 to 170	160 to 180

The temperature of the rolls shall be selected to permit the material to band on the surface of the roll between 1 and 2 minutes after the commencement of the milling.

A-1.2.2 The nip setting shall be determined by the desired thickness of the milled sheet. The thickness of milled sheet shall be slightly higher than the thickness of the moulded sheet or test specimen.

A-2 PROCEDURE

A-2.1 Add the material to the mill rolls. Any material falling through the nip shall be carefully and quickly collected from the tray and returned to the moving rolls. After sheet is formed, continue milling for approximately 5 minutes in such a way that optimum dispersion of all material components is obtained. This normally includes cutting the sheet, allowing it to form a roll and refeeding this roll into the nip. Remove the milled sheet from the rolls without stretching.

A-2.2 Preparation of Moulded Sheet

A-2.2.1 *Apparatus*

a) Hydraulic moulding press, capable of developing a moulding pressure of at least 5 kg/cm^2. The press platen shall be equipped with means of heating and cooling such that the surface can be heated to a temperature of 180 °C and such that the maximum deviation at any point from the temperature at the centre of the platen does not exceed 5°C within the moulding area.

b) Male/Female mould, or window frame between two metal plates. Parting foils (for

example stainless steel plates) can be placed between the materials and the metal surfaces.

A-2.2.2 *Moulding Conditions*

The necessary mass of material to fill a mould is predetermined either by calculation from the known material density, or by making a trial moulding. The moulding temperature shall be in accordance with the requirements given in Table 3.

A-2.3 Procedure

A-2.3.1 Place the required mass of pieces cut from the milled sheet in the preheated mould.

Close the preheated platens of the press and maintain a pressure of approximately 5 to 10 kg/cm^2 for a period of 5 minutes followed by application of pressure of not less than 35 kg/cm^2 calculated on the area of moulding. During this time, there shall be sufficient flow of the material between the mould and the metal surfaces to result in formation of a small amount of moulding flash. Cool the mould to approximately 40°C or, in the case of very soft materials to a lower temperature, while maintaining constant applied pressure. Open the mould and remove the sheet.

A-2.4 Preparation of Test Specimens

Prepare the required test specimens from the moulded sheet by machining or by stamping, using a sharp die of the required shape, the cutting edges of which are free from defects such as notches and burrs.

A-3 CONDITIONING

The conditioning and all standard test determinations shall be made at 27 °C and 65 percent relative humidity in accordance with the requirements of test method unless the relevant test method specified otherwise. The minimum time between the preparation of a test specimen and the test determination shall be 16 hours, except that for electrical properties, shall be 24 hours. If shore hardness values change significantly, a minimum time of 48 hours is necessary.

ANNEX B

(*Clause* 5.3.1)

COLOUR FASTNESS TO DAYLIGHT

B-1 FORM OF TEST SPECIMEN

The specimen may conveniently be a piece of sheet of length 130 mm and width ranging from 15 to 50 mm.

B-2 NUMBER OF THE TEST SPECIMENS

One specimen shall be used.

B-3 EXPOSURE CASE

The exposure case shall consist essentially of an open bottom box of approximate dimensions 900 × 600 × 50 mm covered with a framed lid of glass and containing within it a removable rectangular rack (for carrying the test specimens and wool standards) resting upon a support made of wire mesh.

The details of each of these components shall be as follows:

a) **Lid** — The lid of the exposure case shall consist of framed sheet of window glass 3 mm thick without cross supports, having a free area at least 880 × 550 mm. When in position its lower surface shall be 25 mm from the upper surface of the rack; it shall be supported in the centre by the 25 mm distance piece described below under rack. The lid shall fit snugly and symmetrically on the case.

b) **Rack** — The removable rectangular rack shall consist of five wooden battens attached to cross-members as shown in Fig. 1 (*see* Page 12). The upper and lower battens shall be 65 mm and 38 mm wide respectively and the three middle battens shall each be 90 mm wide. The battens shall be 12·8 mm thick, 50 mm apart and shall be arranged so that there is an air space 860 mm long and 50 mm wide between them. A small wooden distance piece 25 mm long shall be suitably placed on the upper face of the middle batten.

c) A series of 50 mm wide wooden flaps shall be so hinged to each batten (except the 38 mm batten) that the lower 50 mm strip of each batten may be covered. The hinges shall be so arranged that:

   i) when each flap is held parallel to the batten there shall be a space of 1·6 mm between flap and batten; and

ii) when each flap is allowed to fall freely, its lower edge will rest upon the batten.

d) The rack shall fit snugly into the exposure case. When in position the lower surface of the rack shall rest immediately on the upper surface of the wire mesh of the screen.

e) **Wire Screen** — The wire screen shall be carried by a removable rectangular frame incorporating two narrow cross supports, dividing the length of the frame into three equal sections. The wire screen, which shall be of 180 micron woven wire cloth complying with IS 2405 (Part 1) : 1980 shall be fixed to the upper side of the frame so that an area 860 mm long and 560 mm wide of the screen is free from obstruction (except for the cross supports). The frame shall fit snugly into the exposure case.

f) **Location of Exposure Case** — The case shall be situated in the open and facing south. It shall be so supported on legs that its lower front-edge is 760 mm from the ground. The lid, rack and screen shall all be inclined at 45° to the horizontal. The exposure case shall be so placed that no vertical angle greater than 20° nor shall any in a northern direction subtend a vertical angle greater than 70°.

B-4 PROCEDURE

B-4.1 Test specimens shall be fixed at the top and bottom on the rack so that the upper 50 mm are covered by the flap, the next 50 mm are freely exposed and the remaining 25 mm rest on the next lower batten. Each specimen shall be placed neither less than 6·5 mm from any other specimen nor within 6·5 mm of the end of the spaces between the battens, to permit free air circulation round the test specimen.

B-4.2 The dyed wool standards shall be exposed on the same rack. They shall be fixed 6·5 mm apart in a support (*see* Fig. 2) so that 38 mm of each standard is covered by the flap, the next 25 mm is freely exposed and the remaining 12·8 mm rests on the lower edge of the support.

B-4.3 The test specimen and the dyed wool standards so mounted shall be exposed to daylight for a sufficient time to cause standard No. 5 of IS 686 : 1985 to change colour so that the exposed portion of that standard shall have a contrast with the unexposed portion equal to Grade 4 on the Geometric Grey Scale of IS 768 : 1982.

B-4.4 The dyed wool standards shall be examined after enough time to ensure that the specified degree of colour change of standard No. 5 is observed. The glass plate shall be kept clean during the test.

B-4.5 After the prescribed exposure the specimen shall be removed from the rack. Cleaned with soap, complying with grade 1 of IS 285 : 1974 and cold water, dried and examined indoors in a good north light against a white background in comparison with the dyed wool standards.

B-4.6 The colour fastness to daylight of the material under test shall be the number of the dyed wool standard that has changed colour to the same extent as the test specimen.

ANNEX C

(*Clause* 5.3.2)

TEST FOR COLOUR BLEEDING

C-1 FORM OF TEST SPECIMEN

For sheet materials, the specimen shall be a piece 50 mm square, cut from the sheet under test. For extrusion compounds the specimen shall be a piece 50 mm square and 1·25 ± 0·15 mm thick cut from sheet moulded under the conditions specified in Table 3 of Annex A.

C-2 NUMBER OF TEST SPECIMENS

C-2.1 For compounds and sheet of uniform colour one specimen shall be used for colour bleeding test.

C-2.2 For sheet in which more than one colour is present select one specimen which shall be representative of all colours present as agreed to between the purchaser and the supplier and this one specimen shall be used for colour bleeding test.

C-3 PROCEDURE

C-3.1 The specimen shall be placed on a piece of polyvinyl chloride sheet 75 mm square of the following formulation:

	Parts per Mass
Polyvinyl chloride	100
Di-(2-ethylhexyl) phthalate	66·6
Lead stearate	1·5
Cadmium stearate	1·5

C-3.2 The specimen shall then be covered with a 75 mm square of dry, white Whatman No. 44 or eqivalent filter paper. In order to ensure good contact between the filter paper, the specimen and the sheet on which it rests, shall be sandwiched between two pieces of glass plate 75 mm square and 5 mm thick. The various layers

shall be brought into good contact, preferably by rolling. A weight approximately 50 g shall be placed on the top to ensure good contact. The assembly shall be maintained for 72 ± 1 h at 50 ± 2 °C in an air oven. At the end of this time, the assembly shall be removed from the oven its parts separated and the 75 mm square piece of polyvinyl chloride sheet and the filter paper examined for staining, first over a white and then over a black background; white filter paper and photoblack cover paper are suitable for this purpose. If either the filter paper or the polyvinyl chloride sheet is stained it shall be reported that colour bleeding has occurred.

C-4 REPORT

The report shall state whether or not colour bleeding has occured.

ANNEX D

[*Table* 1, *Item* (iii) (a) *and Table* 2, *Item* (vii) (a)]

HEAT AGEING TEST IN OVEN

D-0 GENERAL

This method covers a procedure for estimating the relative resistance of PVC Compounds to elevated temperature ageing under controlled conditions of air circulation. It consists in subjecting test specimens to controlled deteriorating influences for known periods, after which the mechanical properties of aged and controlled samples are measured and the changes are noted.

D-1 APPARATUS

D-1.1 Air circulating oven, provided with tubes and a means for calibrating and controlling air velocity within the tube cells. The air velocity variation shall not exceed 10 percent of the specified velocity. The temperature within the testing chamber shall be uniform within the tolerance given in Table 1 and Table 2 respectively.

D-1.2 The heating medium for the ageing chamber shall be preheated air, circulated within it at atmospheric pressure. The heated air in all the tubes shall be thoroughly circulated. The design of the oven shall be such that heated fresh air enters one end of the tube and is exhausted from the system without being recirculated in the oven by means of fan.

D-1.3 Recording Temperature

Indicating device to measure the temperature near the centre of the chamber.

D-1.4 Rotameter for checking the air velocity.

D-1.5 Specimen Holder

Suitable specimen holders shall be provided which will position the specimens within the tubes, separated from each other and the tube walls, and permit free flow of air around the specimens.

D-2 TEST SPECIMENS

It shall be in Dumb-bell shape in accordance with test piece for tensile strength and elongation at break.

D-3 PROCEDURE

D-3.1 Adjust the air within the tubes to the required test temperature.

D-3.2 Adjust the air flow in each tube to the velocity of air charges per hour between eight and twenty of the volume of the tube cells.

D-3.3 Mount the specimens in holders. Only specimens of identical compositions shall be permitted in any individual tube cell.

D-3.4 Place each loaded holder in a tube cell. Place the tube cell in position in the oven, and age for the specified time and temperature.

D-3.5 At the termination of the ageing interval, remove the holders from the tube cells and allow them to cool to room temperature.

D-3.6 The aged specimens shall be conditioned at 27 ± 2°C, and humidity of 65 ± 5 percent for not less than 16 hours.

D-3.7 The tensile strength and elongation at break is then determined in accordance with IS 8543 (Part 4/ Sec 1) : 1984.

D-3.8 The value expressed as a percentage of the corresponding value for the unaged sample shall not be less than the value specified in Table 1 and Table 2 respectively.

D-4 REPORT

D-4.1 Ageing temperature and period.

D-4.2 Original value and value after ageing of tensile strength and elongation.

D-4.3 Percentage retention after ageing of tensile strength and elongation.

ANNEX E

[*Table* 1, *Item* (iv) *and Table* 2, *Item* (vi)]

DETERMINATION OF VOLUME RESISTIVITY

E-0 GENERAL

This method is for measuring the electrical resistance of the material as determined from the current flowing through the material when a voltage is applied to the opposite faces of a sheet of the material. Since very high electrical resistivity is a distinguishing characteristic of many insulating materials, the resistance of suitable specimens of the materials is usually very high also. Measurements of such resistances may be subject to large errors unless specialised methods such as are specified herein are used.

E-1 APPARATUS

E-1.1 The electrodes should be of material which allows intimate contact with the specimen surface; and introduces no appreciable error because of electrode resistance or contamination of the specimen. The electrode material should be corrosion resistant under the conditions of test. The typical electrode materials which may be used are as follows:

a) *Conductive Polymer* — Conductive polymer electrodes give satisfactory results provided they are applied with sufficient pressure to assure intimate contact with the specimen over the entire area of the electrode. They have the advantage that they can be quickly applied and need not be applied before the specimen is conditioned. Because the polymer is somewhat deformed by the pressure application the area of the guarded electrode and the distance between the guarded and guard electrode are not well defined as in the case of the other electrodes. However, the error in measurement due to this is usually negligible.

b) *Mercury* — Mercury electrodes give satisfactory results but generally are not recommended for continuous use or at elevated temperatures due to possible toxic effects. The mercury forming the upper electrodes should be confined by metal rings whose lower ends are sloped to a sharp edge.

c) *Flat Metal Plates.*

d) *Colloidal Graphite.*

e) *Sprayed Metal.*

f) *Evaporated or Sputtered Metal.*

g) *Conductive Silver Paint* [for details of (d), (e), (f) and (g), *see* IS 3396 : 1979].

E-1.2 Volt Meter — Ammeter

In this method the current is measured by a microammeter or galvanometer. Fig. 3 (*see* page 13) or by d.c. amplifier which indicates current by measuring the voltage drop across a known resistance. Fig. 4 (*see* pages 13 and 14) and the voltage is measured by an indicating voltmeter. In some cases the ratio of voltage to current is measured in single instrument to indicate resistance directly.

OR

E-1.3 Comparison Method

In this method the unknown resistance is compared with a known resistance. This comparison is effected by determining the ratioof the current when the same voltage is applied successively to the two resistance Fig. 5 (*see* page 14) or by balancing two resistances in Weston bridge.

For all of the methods the unknown resistance must be large compared to any standard resistances placed in series with it so that it will have essentially full voltage placed accross it.

E-1.4 Micrometer

E-1.5 Oven capable of maintaining temperature up to 85 ± 2°C.

E-2 DIMENSIONS

Electrodes

The electrodes should conform to the following dimensions (Fig. 6):

a) Upper electrode (Outer electrode) D3 — 100 mm (*Min*)

b) Inner electrode D1—50 mm (*Min*)
76 mm (*Max*)

c) Inner electrode dimensions of guard ring (D2) should be at least 12 mm bigger than the smaller electrode. The outer diameter of guard ring should be 100 mm, *Max.*

E-3 CONDITIONING

E-3.1 The specimen shall be kept at 27 + 2 °C and 65 ± 5 percent relative humidity for not less than 24 hours immediately before testing and the test shall be carried out at 27 + 2 °C and 65 ± 5 percent relative humidity.

E-3.2 V.R. at 70 and 85 °C.

E-3.2.1 *Conditioning*

Place electrodes along with the specimen mounted on electrode in an oven at specified temperature ± 2 °C for a period of 1 h ± 5 minutes.

E-4 PROCEDURE

E-4.1 Measure average thickness of the specimen with the help of micrometer.

E-4.2 The specimens shall be properly mounted as per **E-4.3** and conditioned as per **E-3.1** before resistance measurements are made.

E-4.3 Mounting Specimen

In mounting the specimens for measurement, it is important that there shall be no conductive paths between the electrodes other than those through the specimen. Insulating surfaces should not be handled with bare fingers (acetate rayon gloves are recommended). For referee tests the surfaces should be cleaned with a suitable solvent before conditioning.

E-4.4 Measure the dimensions of the electrode and width of guard gap, g. Make the measurement with a suitable device having the required sensitivity and accuracy (*see* **E-1.2** or **E-1.3**).

E-4.5 Unless otherwise specified, the time of electrification should be 60 s and the applied dose of voltage shall be 500 ± 50 V.

E-4.6 Two specimens shall be used.

E-5 CALCULATION

The volume resistivity shall be calculated from the following formula:

$$V.R. = \frac{A \times RV}{f}$$

where

RV = volume resistance in ohms;
f = average thickness of the specimen;
A = effective area of the guard electrode as shown in the figure.

E-6 REPORT

a) A complete description of material;
b) Type and dimensions of electrodes;
c) Test conditions (temp, relative humidity and time of conditioning); and
d) The arithmetical mean of individual results, *i.e.*, geometrical mean.

ANNEX F

[Table 1, *Item* (v)]

DETERMINATION OF LOSS OF MASS

F-0 GENERAL

Thermoplastic insulation and sheath exposed to heat are subjected to many types of physical and chemical changes. The severity of exposures, in both time and temperature, determines the extent and type of changes that take place. Extended periods of exposure of insulation and sheath to elevated temperatures will generally cause some degradation with progressive changes. These changes are assessed by measuring the loss of mass on subjecting the material to accelerated ageing.

F-1 APPARATUS

F-1.1 Oven, similar type of oven as described in Annex D.

F-1.2 Material, no material other than the test specimen is required.

F-2 TEST SPECIMEN

F-2.1 Test specimen details given in IS 8543 (Part 4/ Sec 1) : 1984 shall be applicable with the following exceptions:

a) Dumb-bell specimens shall have two parallel surfaces over the whole length, their thickness shall be 1.2 ± 0.15 mm; and
b) Marker lines are not required to be applied.

F-2.2 Number of Specimens, three.

F-3 CONDITIONING

No pre-conditioning is required for this test.

F-4 PROCEDURE

F-4.1 Surface area of each test specimen shall be determined in accordance with **F-6.1** and each test specimen shall be weighed accurately, in milligrams.

F-4.2 The specimen shall then be suspended in the tube cells. Each specimen shall be at least 20 mm away from any other specimen and from the wall of the tube cell. No other test specimen of different compound shall be exposed in the tube cells at the same time.

The tube cells shall be suspended vertically in the oven at a temperature and for a duration as specified in Table 1. Not more than 0·5 percent of the oven volume shall be occupied by test specimens.

F-4.3 After this heat treatment, the specimens shall be cooled to room temperature and weighed again.

F-5 TABULATION

Specimen Number	Surface Area A cm^2	Mass before Ageing W_1 Mg	Mass after Ageing W_2 Mg
1			
2			
3			

F-6 CALCULATION AND EXPRESSION OF RESULTS

F-6.1 Surface Area

For Dumb-bell shape test specimen

$$A = \frac{3\,430 + (290\,t)}{100}\ cm^2$$

where

t is the mean thickness of the strips, in millimeters to two decimal places.

F-6.2 Loss of mass of specimen W_2

$$mg/cm^2 = \frac{W_1 - W_2}{A}$$

F-6.3 The median value of the results from each case shall be taken as the loss of mass.

F-7 REPORT

Loss of mass test.

a) Compound type;

b) Batch number;

c) Lot number; and

d) Loss of mass, mg/cm^2.

ANNEX G

[*Table* 1, *Item* (vii) *and Table* 2, *Item* (v)]

COLD BEND TEMPERATURE OF FLEXIBLE POLYVINYL CHLORIDE COMPOUND

G-1 GENERAL

A test used to measure the flexibility of plasticised polyvinyl chloride compounds at low temperatures is carried out by bending a standard specimen to a standard radius while maintained at a predetermined subnormal temperature. Cold bend temperature is the lowest temperature in multiples of 5°C at which none of a set of three test specimens fracture or crack when wound on to a mandrel as described below.

G-2 APPARATUS

Winding Device

The winding device shall consists of a mandrel 5·08 mm in diameter; which can be moved along its own axis by a screw of 6·35 mm pitch and shall be provided with fixed guides for guiding the specimens tangentially onto the surface of the mandrel at an angle of 68·5° to this axis. The mandrel shall be furnished with clamps for securing the ends of the specimens to the mandrel. The clamps shall be such as to impose no greater strains on the specimens than are involved in bending them round the mandrel. The guides for the specimens shall be of rectangular internal section with only sufficient clearance to cover imperfections in the specimens and to avoid stretching them as they are drawn through the guides. A suitable device is shown in the Fig. 7.

G-3 TEST SPECIMEN

The specimen shall be 100 mm long, and 4·8 mm wide cut from the sheet of thickness 1·27 ± 0·08 mm. Minimum 6 specimens shall be tested from one sheet.

G-4 PROCEDURE

G-4.1 Put three specimens in the guides of the winder and one of each shall be secured by a clamp on the mandrel.

G-4.2 The specimen and the winder shall be then immersed in industrial methylated spirit or any other suitable liquid media maintained by the addition of solid carbon dioxide at a suitable temperature which shall be multiple of –5°C. After conditioning for minimum 2 h and maximum 4 h and while still immersed in the cooling medium the specimen shall be wound tightly round the mandrel for three complete helical turns at the rate of one revolution per second.

G-4.3 Withdraw immediately the specimen from the cooling medium and examine for signs of mechanical failure. A specimen shall be considered to have failed if it is completely fractured or its surface shows any cracks. Repeat the test at various temperatures on fresh sets of specimens until two temperatures differing by 5°C are found such that at the higher temperature no specimen fails and at the lower temperature one or more specimen fail.

G-5 REPORT

The cold bend temperature of the material under test shall be reported as the higher of these two temperatures.

ANNEX H

[*Table* 2, *Item* (iv)]

DETERMINATION OF LOSS OF MASS ON HEATING

H-1 GENERAL

The method describes a procedure for determination of loss in weight of a PVC sheet when heated at 130 ± 3°C for 3 h.

H-2 APPARATUS

Oven, capable of maintaining a temperature of 130 ± 3°C.

H-3 TEST SPECIMEN

Specimen shall be 50 × 25 mm in thickness of 1.25 ± 0·15 mm as prescribed in Annex A.

H-4 PROCEDURE

H-4.1 Weigh specimen to the nearest 0.000 1g.

H-4.2 Maintain the oven at 130 ± 3°C.

H-4.3 Place the specimen in the oven supported on 3 wires placed 25 mm apart.

H-4.4 Close the oven door and age the sample for 3 ± 5 min.

H-4.5 Remove the sample from the oven and cool it to room temperature in a dessicator.

H-4.6 Weigh the sample to nearest 0·000 1 gm.

H-5 CALCULATION

H-5.1 Heat ageing loss shall be calculated as follows:

$$A = \frac{W_1 - W_2}{W_1} \times 100$$

where

A = % heat ageing loss,

W_1 = original weight of sample, and

W_2 = final weight of sample.

H-5.2 Two specimens shall be tested in each case and test shall be repeated if both the values differ by more than 0 1 percent.

H-6 REPORT

a) Temperature and duration of test.

b) Percentage of volatile losses.

ANNEX J

(*Clause* 7)

METHODS OF SAMPLING OF FLEXIBLE PVC COMPOUNDS

J-1 GENERAL

J-1.1 In drawing, preparing, storing and handling samples, the following precautions and directions shall be observed.

J-1.2 Samples shall not be taken in an exposed place.

J-1.3 The sampling instrument shall be made of stainless steel or any other suitable material on which the material shall have no action. The instrument shall be clean and dry.

J-1.4 Precautions shall be taken to protect the samples, the material being sampled, the sampling instrument and the containers for samples from adventitious contamination.

J-1.5 The samples shall be placed in a suitable, clean, dry, air-tight metal or glass containers on which the material has no action. The sample containers shall be of such a size that they are almost completely filled by the sample.

J-1.6 Each sample container shall be sealed air-tight with a stopper after filling and marked with full details of sampling, such as, the date of sampling, the month and year of manufacture of the material, etc.

J-1.7 Samples shall be stored in such a manner that the temperature of the material does not vary unduly from the normal temperature.

J-2 SCALE OF SAMPLING

J-2.1 In single consignment all the containers of the same class, same type, same form and belonging to the same batch of manufacture shall be grouped together to constitute a lot. If a consignment is known to consist of containers belonging to different batches of manufacture or different form, the containers belonging to the same batch or manufacture and same form shall be grouped together and each such group shall constitute a lot.

J-2.2 For ascertaining the conformity of the material to the requirements of this specification, samples shall be tested from each lot separately. The number of containers to be sampled shall depend on the size of the lot and shall be in accordance with col 1 and 2 of Table 3.

Table 3 Scale of Sampling

Lot Size	No of Containers to be Selected
Up to 15	3
16 to 50	4
51 to 100	5
101 to 300	7
301 to 500	10
501 to 1000	15
1 001 and above	20

J-2.3 These containers shall be selected at random from the lot and in order to ensure the randomness of selection, procedures given in IS 4905 : 1968 may be followed.

J-3 PREPARATION OF TEST SAMPLES

J-3.1 A suitable sampling instrument made of stainless steel shall be used for this purpose. It shall be capable of taking samples from all points when inserted into the containers.

J-3.2 From each of the containers selected, small portions of the material shall be drawn with the help of this sampling instrument. The total quantity of material collected from each container shall be sufficient to make triplicate determinations for each of the characteristics given in Tables 1 and 2.

J-3.3 Out of these portions, a small but approximately equal quantity of material shall be taken and mixed thoroughly to form a composite test sample. The composite test sample thus formed shall be divided into three equal parts and transferred to separate bottles which are then sealed air-tight and labelled with all the particulars of sampling given in **J-1.6**. One of these bottles shall be marked for the purchaser, another for the supplier and the third for the referee.

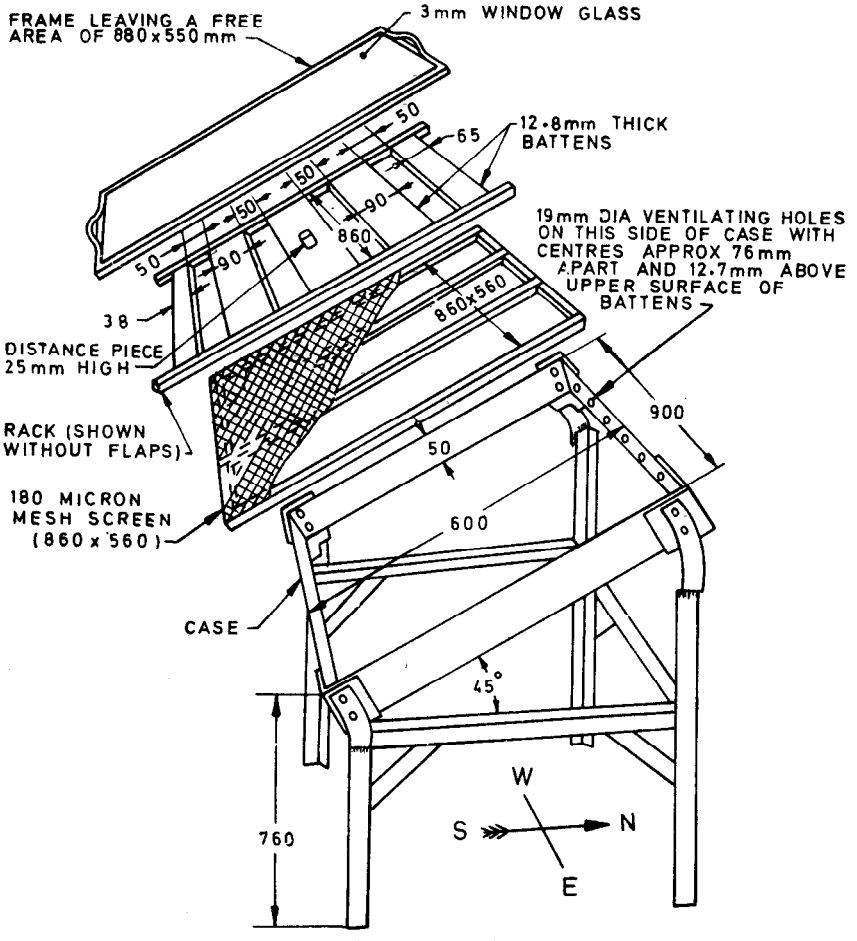
J-3.4 Referee sample shall consist of the composite test samples marked for the purpose and shall bear the seals of the purchaser and the supplier. It shall be used in case of any dispute between the two.

J-4 NUMBER OF TESTS

Test for determining all the characteristics given in Tables 1 and 2 shall be carried out on the composite test samples.

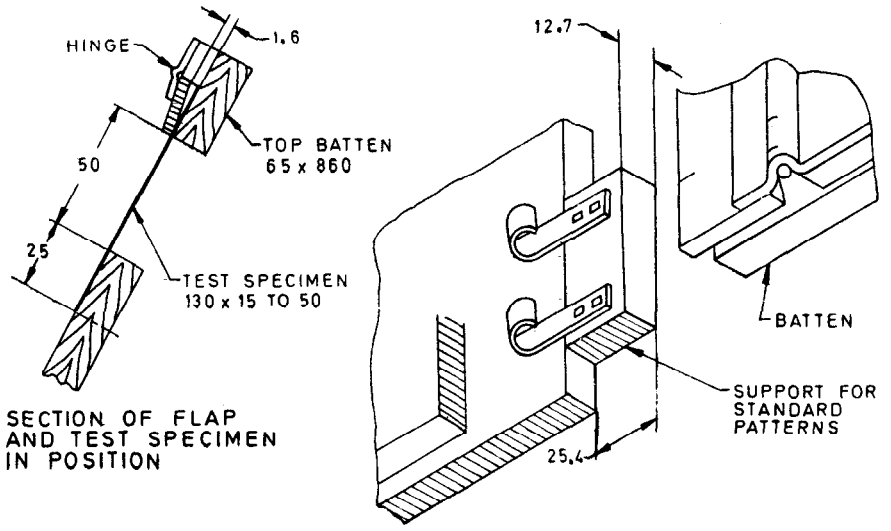
J-5 CRITERIA FOR CONFORMITY

The lot shall be declared as conforming to the requirements of this specification if each of test results on the composite sample satisfies the corresponding requirements given in Tables 1 and 2 as appropriate.



All dimensions in millimetres.

FIG. 1 APPARATUS FOR DAYLIGHT EXPOSURE



All dimensions in millimetres.

FIG. 2 DETAILS REGARDING MOUNTING OF SPECIMENS AND WOOL STANDARDS

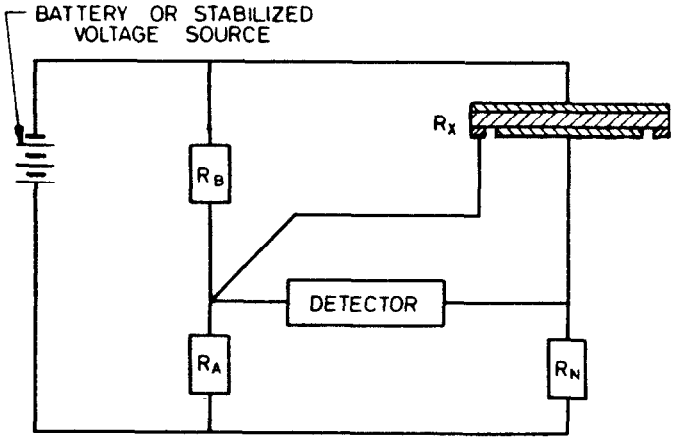
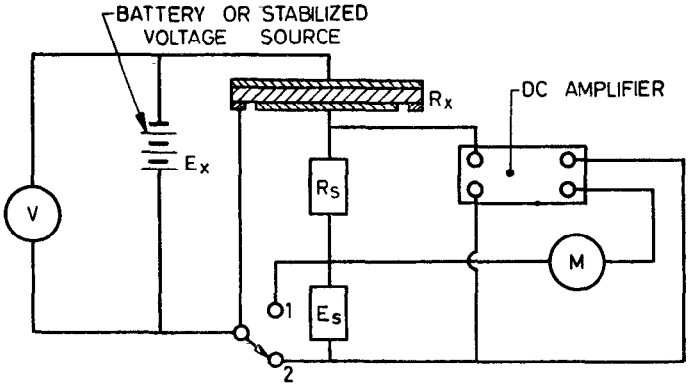
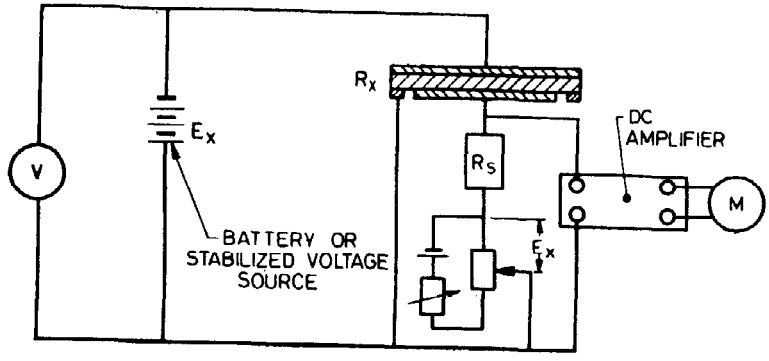


FIG. 3 CURRENT MEASUREMENT BY MICROAMMETER OR GALVANOMETER



4A

FIG. 4 CURRENT MEASUREMENT BY MEANS OF A D.C. AMPLIFIER (*Contd*)



4B

FIG. 4 CURRENT MEASUREMENT BY MEANS OF A D.C. AMPLIFIER

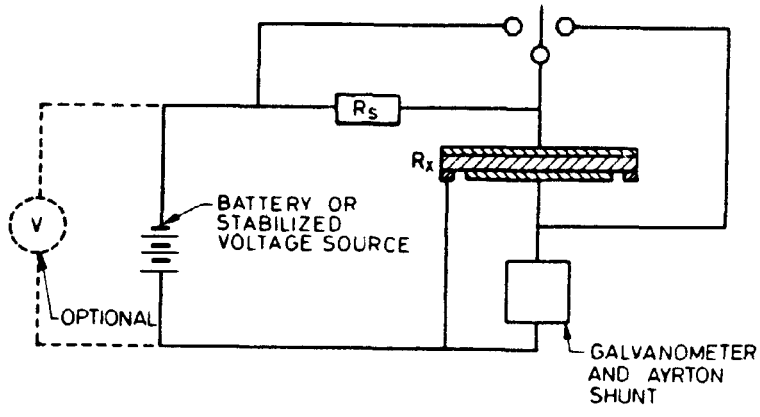


FIG. 5 COMPARISON METHOD — DETERMINATION OF THE RATIO OF CURRENTS WHEN THE SAME VOLTAGE IS APPLIED SUCCESSIVELY TO TWO RESISTANCES

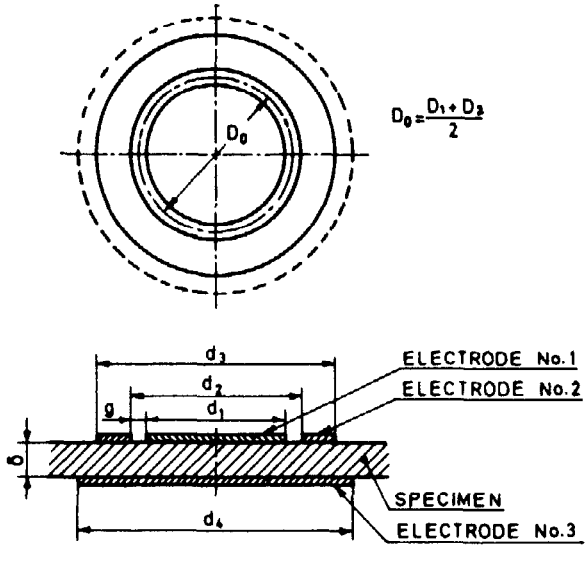
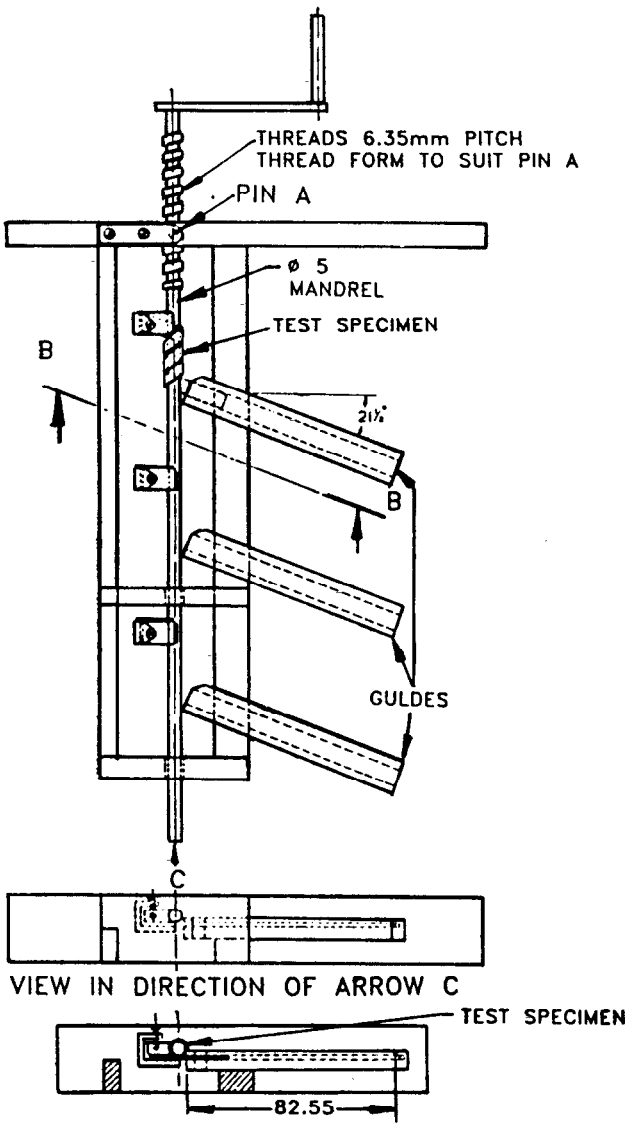


FIG. 6 APPLICATION AND ARRANGEMENT OF ELECTRODES FOR PLATE SPECIMENS



All dimensions in millimetres.

FIG. 7 WINDING DEVICE

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