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Indian Standard

SPECIFICATION FOR
LOW DENSITY POLYETHYLENE FILMS

(Second Revision)

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Indian Standard

SPECIFICATION FOR
LOW DENSITY POLYETHYLENE FILMS

(Second Revision)

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Indian Standard

SPECIFICATION FOR
LOW DENSITY POLYETHYLENE FILMS

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 24 March 1984, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 This standard was first published in 1963 and subsequently revised in 1977. In view of the development of newer non-packaging applications of low density polyethylene films and because of certain anomalies in the specification regarding the values of impact strength and coefficient of friction of LDPE films, the Committee decided to revise the specification on the basis of experience gained over the years and to align it with the latest technology, test methods and trade practices.

0.3 In preparation of this revised specification assistance has been derived from BS 2782 : 1970 Methods of Testing Plastics method 306 F and 311 A; Method 306 F Impact resistance of flexible film with falling dart and Method 311 A Coefficients of friction of polyethylene film; and ASTM D 1894 Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting, for the test method for measuring the coefficient of friction of the films.

0.4 The Committee responsible for the preparation of this standard desired to include requirements for ink adhesion; heat sealability; moisture permeability; puncture resistance; and tear resistance but decided to add these at a later date when adequate data and standard methods of tests are available.

0.5 This standard contains clauses **1.2, 1.3, 2.1.1, 4.1.2** and **5.1** which call for agreement between the purchaser and the supplier.

0.6 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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for natural and black colour (carbon black pigment) low density polyethylene films intended for packaging, canal lining, agricultural operations and post harvest uses, construction work and allied purposes.

1.2 This standard covers flexible, unsupported flat or tubular films 12·5 to 250 μm in thickness and width 175 to 7 500 mm (350 to 15 000 mm slit open width in the case of tubular films), made from polyethylene materials having a density between 0·913 to 0·937 g/ml at 27°C (0·915 to 0·939 g/ml at 23°C).

> Note — When the film is intended for use for fumigation purposes, film of thickness above 175 μm shall be used. The actual thickness of the film to be used shall be as agreed to between the purchaser and the supplier.

1.3 Coloured film other than black shall be as agreed to between the supplier and the purchaser.

2. COMPOSITION

2.1 Natural Compound

2.1.1 The compound used for manufacturing natural film shall consist only of polyethylene resins complying with **2.1.2**. Any additives, such as anti-oxidants, to impart additional qualities to the films, such as slip, may be added in quantity to the resins, as agreed to between the supplier and the purchaser.

> Note — When the film is meant for food contact applications, the compound used shall also comply with IS : 10146-1982†.

2.1.2 The polymers for the natural film shall have a melt flow index between 0·10 to 15·0 g/10 min. The density for the compound from which the film is made shall be between 0·913 to 0·923 g/ml at 27°C (0·915 to 0·925 g/ml at 23°C).

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*Rules for rounding off numerical values (*revised*).
†Specification for polyethylene for its safe use in contact with foodstuffs, pharmaceuticals and drinking water.

2.2 Black Compound — The black compound shall consist of polyethylene resins conforming to **2.1.2** except that the density of the compound shall be between 0·922 to 0·937 g/ml at 27°C (0·924 to 0·939 g/ml at 23°C).

2.2.1 *Carbon Black* — The relevant specifications for carbon black used in polyethylene films are IS : 7497-1974*, IS : 8134-1976†, IS : 10357-1982‡ and IS : 10358-1982§.

2.2.2 The percentage of anti-oxidants in the compound shall not exceed 0·3 percent by mass. The anti-oxidants used shall be physiologically harmless and uniformly dispersed in the compound.

3. GRADES

3.1 The material (film) shall be classified according to the optical properties, impact strength and slip. Each grade shall be designated by a set of 3 numerals. The first one will indicate optical property, the second impact strength, and the third slip property. Whenever numeral 0 is used, it shall mean the material has not been tested for that particular property. For optical properties the numeral 1 shall mean low clarity, numeral 2 normal clarity and numeral 3 high clarity. For impact strength numeral 1 shall indicate low impact strength, numeral 2 normal impact strength and numeral 3 high impact strength. For slip property numeral 2 shall denote low slip, numeral 2 medium slip, numeral 3 high slip and numeral 4 shall mean extra high slip.

Example:

Grade 001 — This shall mean that the film has not been tested for optical properties and impact strength and it is of low slip.

Grade 210 — This shall mean that the film is of normal clarity, low impact strength and slip has not been tested.

Grade 314 — This shall indicate that the film is of high clarity, low impact strength and extra high slip.

NOTE — Although many theoretical combinations of properties are possible with above system of gradation of films all such combinations are practically impossible to achieve with the state of technology and/or processing possibilities at any particular time. It is therefore recommended that when using this standard for specifying the film grades for certain applications, one should consult **4** on requirements and if necessary assistance should be taken from experts, the raw material manufacturers and the producers of the films as to the actual possibility of obtaining various combinations and availability of the required grade of raw material.

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*Specification for high abrasion furnace (HAF) carbon black.
†Specification for intermediate super abrasion furnace (ISAF) carbon black.
‡Specification for general purpose furnace (GPF) carbon black.
§Specification for super abrasion furnace (SAF) carbon black.

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4. REQUIREMENTS

4.1 General

4.1.1 *Appearance* — The film shall be uniform in colour, texture and finish. The material shall be substantially free from pin-holes and undispersed raw materials, streaks and particles of foreign matter. There shall be no other visible defects, such as holes, tears or blisters. The edges shall be free from nicks and cuts visible to unaided eye.

The natural films shall be free from pin-holes.

4.1.2 *Film Form* — The film shall be furnished in the form of flat sheet or rolls or in the form of flat tubing or in any other form as agreed to between the supplier and the purchaser.

4.1.3 *Odour* — The film shall be free from any objectionable odour.

4.1.4 *Density* — The density of the film, when determined in accordance with **A-1** or Method 5 of IS : 8543 (Part 1/Sec 2)-1979* shall be as prescribed in **2.1.2** and **2.2**. However, in case of dispute, the latter shall be the referee method.

4.1.5 *Melt Flow Index* — The melt flow index of the film when determined in accordance with **7** of IS : 2530-1963† shall be as prescribed in **2.1.2**.

4.1.6 *Black Film* — When tested in accordance with:

   a) **10** of IS : 2530-1963†, the percentage of carbon black in material shall be $2\cdot5 \pm 0\cdot5$ percent by mass; and

   b) **16** of IS : 2530-1963†, the dispersion of the carbon black shall be satisfactory.

4.2 Dimensional Requirements

4.2.1 *Nominal Thickness and Nominal Width*

   a) Nominal thickness is the theoretically desired thickness of a film for a particular application; and

   b) Nominal width is the theoretically desired width of a film for a particular application.

4.2.2 *Tolerance on Thickness* — When tested in accordance with **A-2**, tolerance on nominal thickness at any given point and the average

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*Methods of testing plastics: Part 1 Characterization of polymer structure and size, Section 2 Determination of density of solid plastics.
†Methods of test for polyethylene moulding materials and polyethylene compounds.

thickness of polyethylene film for various thicknesses shall be as follows:

Nominal Thickness	Tolerance, Percent
Up to and including 40 μm	± 25
Above 40 μm	± 20

4.2.3 *Tolerance on Width* — The tolerance on width shall be as given below:

Nominal Width	Tolerance
mm	mm
Up to 500	± 5
Above 500 and up to 1 250	± 8
Above 1 250 and up to 2 500	± 20
Above 2 500 and up to 3 000	± 40
Above 3 000 and up to 7 500	$+150, -65$
Above 7 500 and up to 15 000	$+200, -100$

4.3 Yield Tolerance — The actual yield shall be determined in accordance with the method given in **A-3** and shall be within the following tolerance limits of the nominal yield:

One roll	± 10 percent
Lots of 250 kg	± 10 percent
Lots over 250 kg and up to 1 250 kg	± 5 percent
Lots over 1 250 kg	± 3 percent

4.4 Tensile Strength at Break — The tensile strength at break when tested as prescribed in **A-4** for all thicknesses of polyethylene film shall be not less than 11·77 MN/m² (120 kgf/cm²) in lengthwise direction and 8·33 MN/m² (25 kgf/cm²) in crosswise direction.

4.5 Elogation at Break — The elogation at break when tested as prescribed in **A-4**, for various thicknesses of polyethylene film, shall be not less than the value given below:

Thickness of the Film	Elongation at Break, Min	
	Lengthwise, Percent	Crosswise, Percent
From 12·5 μm up to but not including 75 μm	100	350
75 μm and above	200	400

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4.6 Optical Properties — The 45° gloss and haze of the film, when determined in accordance with **A-5**, shall conform to the requirements given below:

Grade	45° Gloss	Haze
Low clarity film	Below 30	Greater than 15 percent
Normal clarity film	30 to 55	10 to 15 percent
High clarity film	Greater than 55	6 to 10 percent

NOTE 1 — These two measurements do not always correlate. The particular measurement concerned with the application of the material shall govern in case of an inconsistency.

NOTE 2 — This clause is not relevant in case of black films and should not be considered in classifying the black films.

4.7 Impact Resistance — The impact resistance of the film shall be as given in **4.7.1** to **4.7.3**.

4.7.1 *Low Impact Resistance Film* — Any LDPE film up to 40 μm thickness having impact strength less than 55 gf when tested by the procedure given in **A-6** using a drop height of 66 cm would be classified as low impact resistant film.

For such films, when tested in accordance with **A-6** using a drop height of 22 cm, the impact failure load shall be not less than given below for appropriate average thicknesses of the film:

Average Thickness of Film μm	Impact Failure Load, Min N (gf)
12·5	0·4 (40)
20	0·6 (60)
25	0 8 (80)
40	1·25 (125)

NOTE — Values for impact failure loads for intermediate thicknesses may be obtained by interpolation.

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4.7.2 *Normal Impact Resistant Film* — When tested by the procedure given in **A-6**, the impact failure load obtained from a drop height of 66 cm shall be not less than that given below against appropriate average thicknesses of the film:

Average Thickness of Film, μm	*Impact Failure Load, Min* N (gf)
40	0·55 (55)
50	0·70 (70)
75	1·00 (100)
100	1·20 (120)
125	1·60 (160)
150	1·85 (185)
175	2·10 (210)
200	2·35 (235)
225	2·60 (260)
250	3·00 (300)

NOTE — Values for impact failure loads for intermediate thicknesses may be obtained by interpolation.

4.7.3 *High Impact Resistant Film* — When tested by the procedure given in **A-6**, the impact failure load obtained from a drop height of 152·4 cm shall be not less than that given below against the appropriate average thicknesses of the film:

Average Thickness of Film, μm	*Impact Failure Load, Min* N (gf)
40	0·50 (50)
50	0·65 (65)
60	0·75 (75)
75	0·90 (90)
100	1·20 (120)
110	1·30 (130)
125	1·55 (155)
150	1·90 (190)
175	2·15 (215)
200	2·50 (250)
225	2·85 (285)
250	3·20 (320)

NOTE — The values for impact failure loads for intermediate thicknesses may be obtained by interpolation.

4.8 Slip — The kinetic coefficient of friction for the material when tested in accordance with **A-7** shall be as follows:

a) Low slip film	Greater than 0·40
b) Medium slip film	Greater than 0·30 and up to and including 0·40
c) High slip film	Greater than 0 20 and up to and including 0·30
d) Extra high slip film	Up to and including 0·20

NOTE — Since heavy duty films used in agricultural operations like green-housing, mulching, etc; or post harvest uses; canal lining; construction work and allied purposes; are made from LDPE grades containing no slip additives, the above clause is of little relevance for this type of films and should not be considered in classifying the films.

4.9 Special Requirements

4.9.1 *Heavy Duty Film* — Low density polyethylene films for canal lining and other heavy duty applications like mulching, green houses, post harvest operations, construction work and allied purposes, shall have an MFI not more than 0 30 g/10 min when tested by the method given under **7** of IS : 2530-1963*. The tensile strength of such films shall be not less than 140 kgf/cm² in machine direction and 110 kgf/cm² in transverse direction. Films shall also meet the requirement of impact strength as given in **4.7.3**.

4.9.2 *Film Having a Width of Less Than 175 mm (350 mm Slit Open Width in Case of Tubular Films)* — Though films of width less than 175 mm (350 mm slit open width in case of tubular films) are not covered by this specification, if one intends to test such films, used for general purposes or agricultural operations like nursery bags, it could be got tested only for tensile strength in machine direction and it should not be less than 120 kgf/cm².

5. PACKING AND MARKING

5.1 Packing — The roll folded polyethylene film shall be packed as agreed to between the purchaser and the supplier.

5.2 Marking — Each roll folded film shall be marked legibly with the following information:

a) Manufacturer's name and recognized trade-mark, if any;

b) Grade of the film;

c) Width of the roll/folded film;

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*Methods of test for polyethylene moulding materials and polyethylene compounds.

  d) Mass of the roll/folded film;

  e) Thickness of the film; and

  f) Batch number and date of manufacture.

5.3 BIS Certification Marking

The product may also be marked with Standard Mark.

5.3.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6. SAMPLING

6.1 Lot — In any consignment, all rolls/folded films of the same grade shall be grouped together to constitute a lot.

6.1.1 Tests for determining the conformity of the lot to the requirements of the specification shall be done on each lot separately. The number of rolls/folded films to be selected for this purpose shall be in accordance with col 1 and 2 of Table 1.

6.1.2 The rolls/folded films shall be selected at random from the lot. In order to ensure randomness of selection, procedures given in IS : 4905-1968* may be followed. In case this standard is not readily available, the following procedure may be adopted:

Starting from any roll/folded film in the lot, count them in one order as 1, 2, ... ,etc, up to r and so on, where r is the integral part of N/n. Every rth roll/folded film thus counted shall be withdrawn till the required number of rolls/folded films are taken from the lot.

6.2 Number of Tests and Criteria for Conformity

6.2.1 From each of the rolls folded films selected according to **6.1.2**, approximately 10 m^2 of the film of full width shall be cut, care being taken to exclude not less than 2-metre lengths of film (or three full turns of the roll) from either end. The test specimens for the various tests shall be cut from different parts of each of the 10 m^2 pieces.

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*Methods for random sampling.

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6.2.2 Each of the pieces as obtained in **6.2.1** from a lot shall be examined for appearance (*see* **4.1.1**), density (*see* **4.1.4**), dimensional requirements (*see* **4.2**) and yield tolerance (*see* **4.3**). Any piece which does not meet the requirement of any of the above characteristics shall be considered as defective.

6.2.3 If the number of defectives found (*see* **6.2.2**) is less than or equal to the corresponding permissible number of defectives given in col 3 of Table 1, the lot shall be tested for the remaining requirements of the specification.

TABLE 1   SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF
DEFECTIVES

(*Clauses* 6.1.1 *and* 6.2.3)

LOT SIZE	NUMBER OF ROLLS/ FOLDED FILMS TO BE SELECTED	PERMISSIBLE NUMBER OF DEFECTIVES
N	n	
(1)	(2)	(3)
1	1	0
2 to 15	2	0
16 to 40	3	0
41 to 65	5	0
66 to 110	7	0
111 to 180	10	0
181 to 300	15	1
301 to 500	25	1
501 to 800	35	2
801 to 1 300	50	3
1 301 and above	75	4

6.2.4 The lot having been found satisfactory according to **6.2.3** shall be tested for tensile strentgh at break (*see* **4.4**), optical properties (*see* **4.6**), impact resistance (*see* **4.7**) and slip (*see* **4.8**). For this purpose the rolls already tested according to **6.2.2** and found satisfactory shall be used for testing any of these characteristics. In case there are more than 15 rolls/folded films, 15 rolls/folded films shall be selected from them at random. Specimen(s) for these tests shall be cut from 10 m² piece already taken from each roll/folded film selected (*see* **6.2.1**).

6.2.4.1 The lot shall be deemed to have satisfied these requirements if all the test results for different characteristics given in **6.2.4** are found meeting the relevant requirements of the specification.

6.2.5 The lot shall be declared as conforming to the requirements of the specification, if the requirements for various characteristics as given in **6.2.3** and **6.2.4** are satisfied.

A P P E N D I X A

(*Clause* 4)

¦ TESTING OF LOW DENSITY POLYETHYLENE FILMS

A-1. DETERMINATION OF DENSITY

A-1.1 Preparation of Test Specimen — Cut from the roll/folded film three pieces of the material under test of an area 100 to 225 mm² from different parts of the roll/folded film using a sharp blade.

A-1.2 Conditioning of the Specimen — The specimen shall be conditioned by submerging it in boiling water for 30 minutes followed by conditioning at 27 ± 0·20°C for at least 24 hours to make it bubble free.

A-1.3 Reagent

A-1.3.1 *Dilute Alcohol* — Having a density of 0·902 6 to 0·907 6 g/ml at 27°C, prepared by diluting ethyl alcohol with distilled water.

A-1.4 Procedure — Pipette 100 ml of dilute alcohol into a clean Drechsel bottle kept immersed in a water-bath maintained at 27 ± 0·1°C. After temperature equilibrium has been attained, lower one test specimen of polyethylene film carefully into the dilute solution avoiding any adhering air bubbles. Add from a burette (conforming to class A of IS : 1997-1961*) distilled water, 0·2 ml at a time, with stirring. When the specimen remains just suspended in the solution well away from the glass surface, the density of the solution and the specimen is taken to be the same. Prepare a calibration curve for the density of dilute alcohol by adding increasing amounts of water and determining the density. Read off the density of the specimen from the calibration curve. For an accurate result, density of solution at the end may also be determined with a pyknometer or specific gravity·bottle at 27 ± 0·10°C. Carry out the test in a similar manner on the second specimen.

A-1.5 Calculation — Calculate the density of the two specimens to the fourth decimal place. If the two values vary by more than 0·000 5 reject the readings and repeat the tests until the difference between the two values is not greater than 0·000 5. Report the mean of the two values as the density.

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*Specification for burettes.

A-2. DETERMINATION OF THICKNESS

A-2.1 Apparatus

A-2.1.1 A deadweight dial micrometer with a flat anvil of 6 mm diameter or larger in area and 4·8 mm diameter flat surface on the head of the spindle, or a spring micrometer which has been calibrated against a deadweight dial micrometer shall be used. In case of dispute, only deadweight dial micrometer shall be used and the reading shall be taken between 15 seconds and 2 minutes after the load is applied.

A-2.1.2 This method is capable of producing measurements with a maximum error of ± 0·000 25 cm.

A-2.2 Specimens — Test five specimens, at least 5 × 5 cm in area, taken uniformly across the width of the test piece.

A-2.3 Procedure — Dry and clean the surface of the anvil and spindle head, and of the specimen. Place the specimen on the anvil and lower the spindle head on to it slowly. The total load applied by the spindle shall be 110 g. Make one measurement on each specimen approximately at the centre of the specimen. Take mean of the measurements of all the specimens of a sample to obtain the average thickness of the sample.

A-3. DETERMINATION OF YIELD TOLERANCE

A-3.1 Calculation of Actual Yield — Yield is the amount of area provided by a given mass of a film of specified thickness. The actual yield Y_a shall be calculated as follows:

$$Y_a, \text{cm}^2/\text{kg} = \frac{A}{M}$$

where

$A =$ area in cm^2 calculated from the length and the width of the roll/folded film, and

$M =$ mass in kg of the film on the roll/folded film.

A-3.2 Calculation of Nominal Yield — The nominal yield Y_n shall be calculated as follows:

$$Y_n, \text{cm}^2/\text{kg} = \frac{1\ 000}{dt}$$

where

$d =$ density in g/ml as determined in **A-1**, and

$t =$ nominal thickness in cm as determined in **A-2**.

A-3.3 Calculation of Deviation of Actual Yield from the Nominal Yield — The deviation of actual yield from the nominal yield shall be calculated as follows:

$$D = \frac{(Y_n - Y_a)}{Y_n} \times 100$$

where

D = deviation from the nominal yield in percent, and

$Y_n,\ Y_a$ = nominal yield and actual yield respectively as determined in **A-3.2** and **A-3.1**.

A-4. DETERMINATION OF TENSILE STRENGTH AND ELONGATION AT BREAK

A-4.1 Apparatus

A-4.1.1 *Tensile Testing Machine* — The tensile testing machine used shall maintain a rate of traverse of one grip as constant as possible. The mean value of the speed of separation shall be such that the initial strain rate on the test specimen is 10 mm/mm of the specimen per minute (for 50 mm specimen gauge length the speed should be 500 mm/min). The load scale shall be accurate to within one percent or 0·1 N whichever is less. The load range shall be such that the breaking load of the test pieces falls between 15 percent and 85 percent of the full scale reading.

NOTE — It is recommended that the load scale be calibrated at least once every 12 months, using dead weights added successively.

A-4.2 *Preparation of Test Pieces* — Gauge length of the specimens shall be 50 ± 1 mm and the width shall be 10 to 25 mm. Cut five test pieces from the sample in the lengthwise direction and a further five in the crosswise direction. The total length of the specimen should be at least 50 mm longer than the gauge length. Measure the thickness using a suitable micrometer.

A-4.3 Procedure — Condition the test pieces for not less than one hour at a temperature of 27 ± 2°C and 65 ± 5 percent relative humidity and clamp their ends in the machine at the grips separated by 50 mm. Start the machine at the preadjusted speed of 500 mm/min and note the load and elongation at break.

A-4.4 Calculation and Report

A-4.4.1 *Tensile Strength at Break* — The tensile strength at break shall be calculated in MN/m² (kg cm²) from the original area of cross section. The mean of five results shall be expressed for the lengthwise and crosswise samples.

A-4.4.2 *Elongation at Break* — Elongation at break shall be expressed at percentage of the original length between the reference lines. The mean of five results shall be expressed for the lengthwise and crosswise samples.

A-5. DETERMINATION OF OPTICAL PROPERTIES

A-5.0 The optical properties of the polyethylene film shall be determined by the two methods given in **A-5.1** and **A-5.2**.

A-5.1 Gloss Method

A-5.1.1 *Apparatus* — Gloss meter.

A-5.1.2 *Specimen* — The specimen shall have a smooth surface, since surface warpage, waviness or curvature seriously affect test results.

A-5.1.3 *Procedure* — Set up the gloss meter at 45°. For calibrating the instrument, adjust the gloss meter to read correctly the gloss of a highly polished standard and then read the gloss of a standard having poorer image-forming characteristics. If the gloss meter reading for the second standard does not agree within one percent of its assigned value, re-adjust the gloss meter until reading within one percent is obtained. Take reading with the polyethylene film by replacing the standard used for calibrating the instruments. Repeat it five times with different specimens.

A-5.1.4 *Report* — Report the average specular gloss reading at 45°.

A-5.2 Haze Method — The haze of the specimen is the percentage of transmitted light which in passing through the specimen deviates from the incident beam by forward scattering. For the purpose of this method only light flux deviating more than 2·5° on the average is considered to be haze.

A-5.2.1 *Apparatus* — Haze meter.

A-5.2.2 *Procedure* — Illuminate the specimen by unidirectional beam making an angle with the direction of its axis not exceeding 3°. Determine

the following four readings with the haze meter:

Reading Designation	Specimen in Position	Light Trap in Position	Reflectance Standard in Position	Quantity Represented
T_1	No	No	Yes	Incident light
T_2	Yes	No	Yes	Total light transmitted by specimen
T_3	No	Yes	No	Light scattered by instrument
T_4	Yes	Yes	No	Light scattered by instrument and specimen

Repeat readings for T_1, T_2, T_3 and T_4 with other position of the specimen to determine uniformity.

A-5.2.3 *Calculation*

A-5.2.3.1 Calculate total transmittance T_t as follows:

$$T_t = T_2/T_1$$

A-5.2.3.2 Calculate diffuse transmittance T_d as follows:

$$T_d = \frac{T_4 - T_3(T_2/T_1)}{T_1}$$

A-5.2.3.3 Calculate the percentage of haze as follows:

$$\text{Haze, percent} = \frac{T_d}{T_t} \times 100$$

A-6. DETERMINATION OF IMPACT RESISTANCE

A-6.1 Terminology

A-6.1.1 *Impact Failure Load* — It is the load at which 50 percent of the specimens fail when tested by this method.

A-6.2 Apparatus — The apparatus shall be assembled as shown in Fig. 1. It could also be assembled suitably using the vacuum clamp as described in **A-6.2.1.2.**

A-6.2.1 *Clamp* — Annular specimen clamp as prescribed in **A-6.2.1.1.**

17
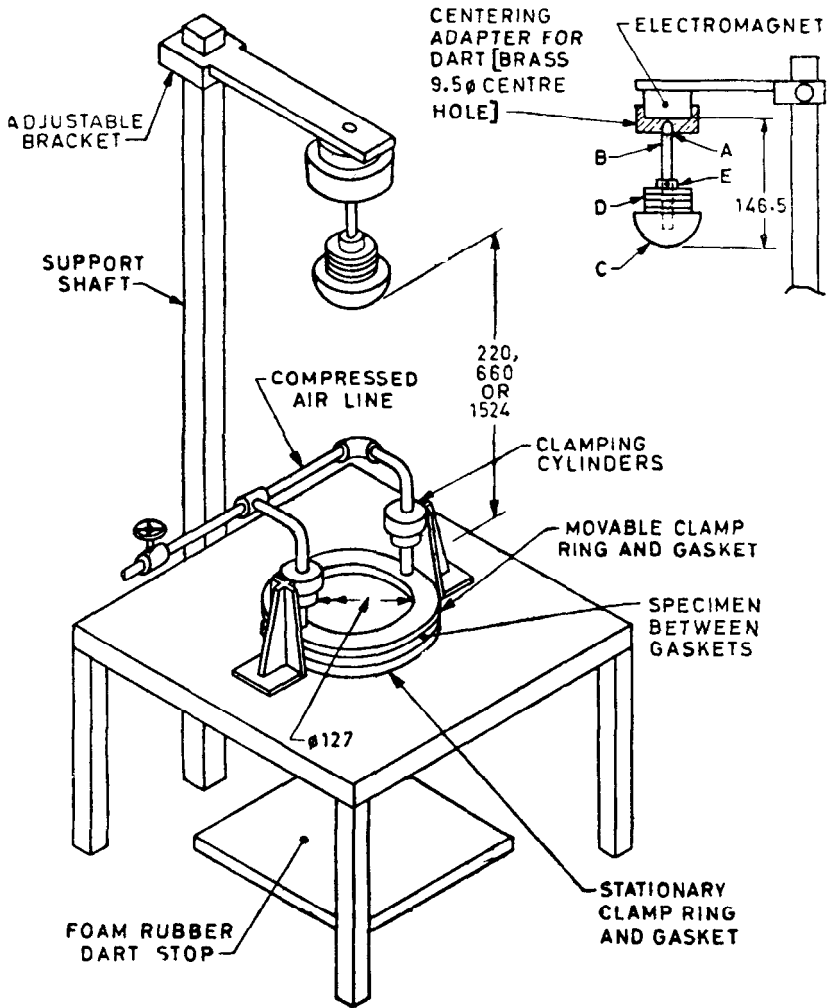
Legends Dart Assembly

A — Steel shaft tip — 6·4 mm OD × 12·7 mm long
B — Dart shaft — 6·4 mm and at least 115 mm long
C — Hemispherical head 38·1 mm in diameter
D — Removable weights
E — Collar and screw

All dimensions in millimetres.

FIG. 1   IMPACT RESISTANCE TESTER

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A-6.2.1.1 *Annular specimen clamp* — A two piece annular specimen clamp having an inside diameter of 12·7 cm and conforming to the following requirements:

a) The lower or stationary half of the clamp shall be rigidly mounted so that the plan of the specimen is horizontal and at an angle of 90° with respect to the upright dart-supporting member of the apparatus.

b) The upper or movable portion of the clamp shall be designed to maintain positive and planer contact with the lower portion of the clamp when in position. This portion of the clamp shall be provided with suitable means for maintaining sufficient contact with the lower clamp to hold the film specimen firmly in place during the test.

c) Gasketing materials prepared from rubber or similar material shall be affixed to the specimen contact surfaces of both clamps. This provides a cushion which minimizes thickness variation effects and also allows firm gripping of the specimen and minimizes slippage.

A-6.2.1.2 *Vacuum clamp* — The vacuum operated clamp as shown in Fig. 2A and Fig. 2B and used for supporting the specimen at its periphery in a horizontal plane during the test. Means are provided for reducing the air pressure in the annulus under the metal gauze so that the difference in pressure between the two sides of the specimen is $750 \times 10^2 \text{N/m}^2$ (560 mmHg) (to hold the test specimen in position when it is placed on the face of the specimen holder).

The clamping ring shown in Fig. 2C for use with the vacuum operated specimen holder when film is to be tested that is thicker than 100 μm or tends to be stiff or slippery.

A-6.2.2 *Adapter* — An elctro-mechanical or similar suitable device for use in supporting and instantaneously releasing the dart so that it will fall freely on to the centre of test specimen in the specimen holder.

A-6.2.3 *Dart* — Consisting of a 3 81 cm diameter hemispherical head fitted with 0·64 cm diameter shaft 11·5 cm long, to accommodate removable mass. The head shall be constructed of aluminium, phenolic plastic or other low density material of similar hardness. The shaft shall be attached to the centre of the flat upper surface of the head with its longitudinal axis at 90° to the surface. The shaft shall be made of aluminium with a 1·27 cm long steel tip at the end for supporting it in the adapter.

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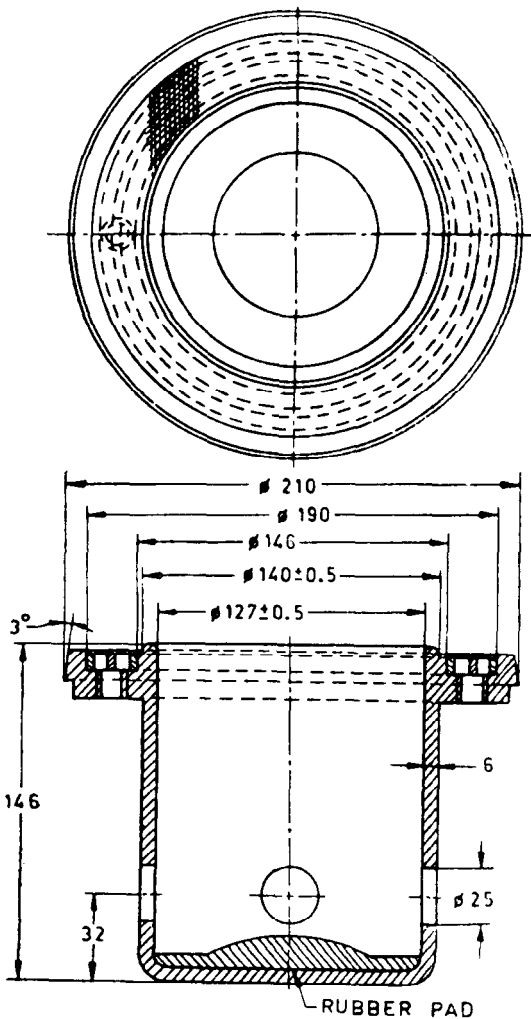
All dimensions in millimetres.

FIG. 2A VACUUM-OPERATED SPECIMEN HOLDER

20

SERRATIONS

METAL GAUZE

2.5

3

SERRATED FACE
FULL CIRCUMFERENCE

R 1.5
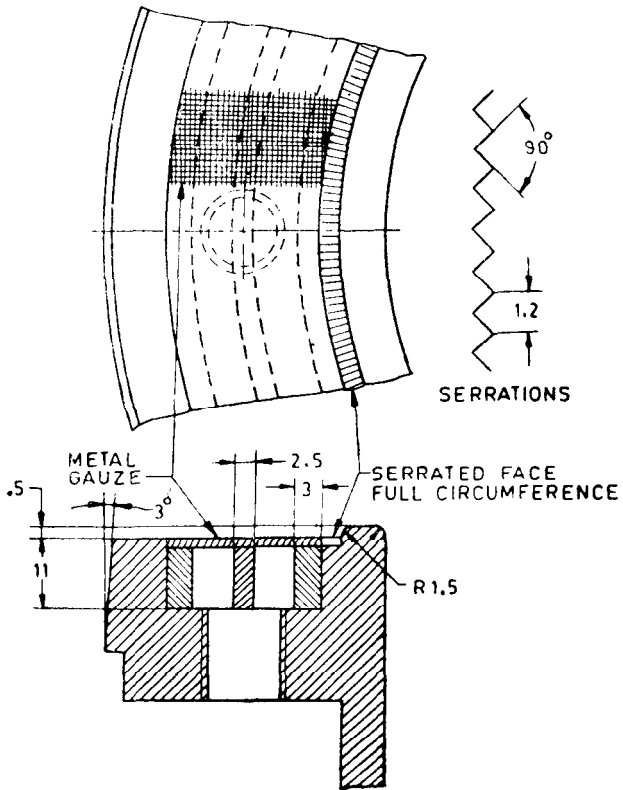
All dimensions in millimetres.

FIG. 2B   VACUUM-OPERATED SPECIMEN HOLDER DETAILS OF UPPER PART OF
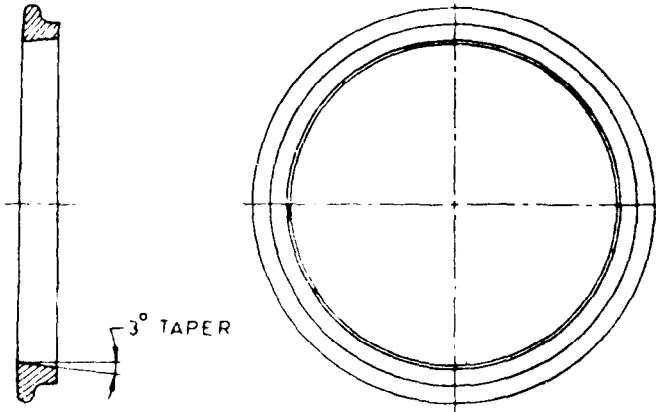SPECIMEN HOLDER

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FIG. 2C   CLAMPING RING FOR SPECIMEN HOLDER

A-6.2.4 *Masses* — Stainless steel detachable masses are suggested as follows:

a) Twenty-four masses of 15·0 ± 0·1 g each, having approximate dimensions of 3 cm in diameter, with a hole in the centre 0·61 cm in diameter and 0·25 cm thickness; and

b) Five masses of 5·0 ± 0·1 g each, similar in construction to those specified in (a) above except that the thickness shall be altered to obtain the specified mass.

NOTE — Additional masses may be constructed for use, if it is necessary to extend mass beyond that attainable when using all the masses in the set suggested above.

A-6.2.5 *Positioning Device* — Means shall be provided for positioning the dart at the following drop heights from the impinging surface of the dart head to the surface of the test specimen:

	Drop Height mm
Low impact resistant film	220
Normal impact resistant film	660
High impact resistant film	1 524

A-6.2.6 *Micrometer* — Accurate to ± 0˙000 25 cm in the range of 0˙000 25 cm to 0˙025 cm for measuring specimen thickness.

A-6.2.7 *Cushioning and Sheilding Devices* — To protect personnel and to avoid damaging the impinging surface of the dart.

A-6.3 Test Specimens — Test specimens shall be large enough to extend outside the specimen clamp gaskets at all points. The specimens shall be representative of the material under test and shall be free from pinholes, wrinkles, folds or other obvious imperfections, unless such imperfections constitute variables under test.

A-6.4 Procedure

A-6.4.1 Place the specimen over the bottom portion of the clamp, making certain that it is uniformly flat, free of folds and that it covers the gasket at all points. Clamp the specimen in place by applying annular pressure with the top portion of the clamp. Position the dart vertically with the steel shaft tip inserted in the adapter and the imping-ing surface of the dart at the appropriate height from the film surface. Release the dart. Care shall be taken to avoid multiple impact in cases where the dart bounces off the specimen. The operator should attempt to catch the dart in such cases to prevent damage to the impinging surface.

A-6.4.2 Examine the specimen to determine whether it has failed or not. Failure is defined as any break through the film. Such a break may be observed readily by viewing the specimen under back lighting conditions. Use a new specimen for each impact.

A-6.4.3 Before beginning the test, a few trial runs shall be made to establish approximately the working range of masses which will break the film. Then for at least three dart masses selected to give percentage failure between 20 and 80, a minimum of ten test specimens at each dart mass shall be tested.

A-6.5 Determination of Impact Failure Load — Plot the percentage of failures against total mass of the falling dart on a graph paper and determine the results graphically. The dart mass at which 50 percent of the specimens fail shall be read from the graph and will give value for impact failure load.

A-7. DETERMINATION OF SLIP

A-7.0 General — The coefficient of friction is the ratio of the frictional resistance to the normal pressure acting on two surfaces in contact. This coefficient of friction is an inverse measure of the relative ease with which the surface of one material will slide over a similar surface or over the surface of another material.

Any of the following two methods (A & B) can be adopted for measurement of coefficient of friction of low density polyethylene films. However in case of any dispute, the result obtained by method A would be considered as the referee one.

A-7.1 Method A

A-7.1.1 *Apparatus* — The apparatus shall consist the following.

A-7.1.1.1 A sled of 150 × 100 mm weighing 700 g with suitable eye screw at one end. The underside of the sled is covered with a 3 mm layer of microcellular rubber sheet having density of about 0·6 g/ml. The total contact area should be 140 cm² so that pressure exerted by the sled is 5 g/cm².

A-7.1.1.2 700 × 180 mm smooth horizontal planes on which the film can be held by a vacuum clamping device, operating through a channel around the periphery of the bed. Vacuum is applied by means of an external vacuum pump.

A-7.1.1.3 A motorised constant speed drive; operating on 220/240V, 50 Hz to move the sled at a speed of 800 ± 80 mm/min over a distance of 400 mm.

A-7.1.1.4 A strain gauge transducer (load cell) of 1 000 g capacity.

A-7.1.1.5 A force meter to directly indicate the load measured by the load cell.

A-7.1.2 *Test Specimens* — All precautions described in **A-7.2.3** shall be taken in this case also. However, the specimen for the plane shall be 675 mm in machine direction and 255 mm in the transverse direction. The specimen for the sled shall be 200 mm in machine direction and 200 mm in the transverse direction.

A-7.1.3 *Procedure* — Place large specimen on the plane so that the machine direction of film is parallel to the length of the plane. Apply vacuum to anchor the specimen on the plane in an unstretched wrinkle free manner. Attach the smaller specimen on the sled by folding the ends over the top of the sled and fixing by cellotape. This specimen shall be attached to the sled tightly and smoothly in an unstretched and wrinkle free manner. The machine direction of the specimen shall be parallel to the length of the sled.

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A-7.1.3.1 Start the constant speed drive and note the maximum load on the force meter at the start of the movement of the sled. This load is used to calculate the static coefficient of friction.

A-7.1.3.2 Allow the sled to move 400 mm on the plane and note the average reading on the force meter throughout the movement of the sled. This average value is used to calculate the dynamic coefficient of friction.

A-7.1.3.3 Remove the film specimen from both the plane and sled to make the apparatus ready for next set of specimen. No specimen surface shall be tested more than once.

A-7.1.4 *Calculation*

A-7.1.4.1 Static coefficient of friction μ_s is given by

$$\mu_s = \frac{A}{B}$$

where

$A =$ initial maximum reading, and

$B =$ mass of the sled.

A-7.1.4.2 Dynamic coefficient of friction μ_d is given by

$$\mu_d = A/B$$

where

$A =$ average reading on the force meter during the movement of the sled, and

$B =$ mass of the sled.

A-7.2 Method B

A-7.2.1 *Apparatus* — The apparatus shall consist of the following.

A-7.2.1.1 The sled is a metal block of $63.5 \times 63.5 \times 6$ mm size with a suitable eye screw fastened in one end. A microcellular rubber sheet having density of about 0.6 g/ml and 3.2 mm thick is wrapped securely around the sled end to end and fastened in position. The weight of the wrapped sled shall be 200 ± 5 g.

A-7.2.1.2 Nylon monofilament of 0.05 mm diameter and capable of supporting 3.6 kg load.

A-7.2.1.3 A universal testing machine can be used for measuring the frictional force to ± 5 percent of its value.

A-7.2.1.4 A horizontal plane made out of polished plastic (acrylic or rigid PVC sheeting is preferred) wood or metal sheet of approximately 150 × 300 × 1 mm size is securely mounted, levelled and attached to the lower crosshead of a constant rate-of-motion universal testing machine. The plane may be covered by a smooth flat piece of glass to provide a smooth support for the specimen. A low friction pulley is attached to the end or at the edge of this plane and centered on the crosshead directly beneath the load cell of the testing machine.

A-7.2.2 *Test Specimens* — Extreme care should be taken in handling the material to keep the surface free of dust, lint, or finger prints. The specimens for the plane should be 600 mm in machine direction and 150 mm in transverse direction. Specimen for the foam rubber wrapped sled shall be 120 mm square. Both the specimens shall be cut from contiguous area of the same piece. Sufficient block and plane specimen of each sample shall be cut so that tests of side A to side A, side A to side B, and side B to side B can be made.

A-7.2.3 *Procedure* — Tape the specimen for plane smoothly without any wrinkle on the horizontal plane with the machine direction of the film corresponding to the length of the plane. Also tape the edges of the 120 mm square specimen to the back of sled using cellophane tape. Wrinkles should be eliminated by pulling the specimen tight without stretching it. Machine direction of the specimen should be parallel to the length of the sled.

A-7.2.3.1 Lightly place the specimen covered sled in position at the rear end of the horizontal specimen. Attach the nylon filament to the sled through its eye screw, place the filament beneath the pulley upward to tie it tightly with the load cell to the universal testing machine.

A-7.2.3.2 Start the moving crosshead at a previously adjusted speed of 152 ± 30 mm/min. Due to the frictional force, the sled may not start moving immediately until the pull on the sled is equal to, or exceeds the static frictional force acting at the contact surfaces. Record this initial maximum reading to calculate the static coefficient of friction.

A-7.2.3.3 Allow the sled to slide uniformly over the planes for approximately 130 mm. Draw a best straight lines between the maximum and minimum points of the graph on the chart recorder. Calculate the dynamic coefficient of friction, using the mean load represented by the straight line.

A-7.2.3.4 Remove the film specimen from both the sled and the horizontal plane to make the set-up ready for next set of specimen. No specimen surface should be tested more than once.

A-7.2.4 *Calculation*

A-7.2.4.1 Static coefficient of friction μ_s is given by

$$\mu_s = A/B$$

where

$A =$ initial maximum reading, and

$B =$ mass of sled in g.

A-7.2.4.2 Dynamic coefficient of friction μ_d is given by

$$\mu_d = A/B$$

where

$A =$ mean load represented by the straight line, and

$B =$ mass of sled in g.

Polyethylene Films & Laminates Subcommittee, PCDC 12 : 8

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AMENDMENT NO. 1 NOVEMBER 1993
TO
IS 2508 : 1984 SPECIFICATION FOR LOW DENSITY POLYETHYLENE FILMS

(*Page* 9, *clause* **4.7.3**) — Read as follows in place of the existing:

'**4.7.3** *High Impact Resistant Films* — When tested by the procedure given in **A-6**, the impact strength failure load obtained from a drop height of 152.4 cm with a dart of 51 mm diameter hemispherical head shall be not less than that given below against the appropriate average thickness of the film:

Average Thickness of Film (micron)	Impact Failure Load Min, gf
50	90
75	125
100	165
125	210
150	255
175	295
200	340
225	380
250	425

NOTE — The values for impact failure loads for intermediate thickness may be obtained by interpolation.'

(*Page* 10, *clause* **4.9.1**) — Read as follows in place of the existing:

'**4.9.1** *Heavy Duty Film* — Low density polyethylene films for canal lining and other heavy duty application like green houses, post-harvest operation, construction work and allied purposes, packaging etc, shall have tensile strength not less than140 kgf/sq.cm in machine direction and 110 kgf/sq.cm in transverse direction. Film shall also meet the requirements of impact strength as given in **4.7.3**.'

(PCD 12)

AMENDMENT NO. 2   MAY 2002
TO
IS 2508 : 1984   SPECIFICATION FOR LOW DENSITY POLYETHYLENE FILMS

(Second Revision)

(*Page* 7, *clause* **4.4**, *last line*) — Substitute '85' *for* '25'.

(*Page* 10, *clause* **4.9.2**) — Insert the following new clause after **4.9.2:**

'**4.10   Tear Resistance** — The values as agreed to between the purchaser and the supplier when determined by the method given in IS 13360 (Part 5/Sec 23) : 1996†/ISO 6302-2 : 1983'.

(*Page* 10, *footnote*) — Insert the following new footnote at the end:

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†Plastics — Methods of testing : Part 5 Mechanical properties, Section 23 Determination of tear resistance of plastics film and sheeting — Elmendorf Method.'

(PCD 12)

AMENDMENT NO. 3 DECEMBER 2007
TO
IS 2508 : 1984 SPECIFICATION FOR LOW DENSITY POLYETHYLENE FILMS

(Second Revision)

[*Page 9, clause* **4.7.3** (*see also Amendment No.* 1)] — Insert the following at the end:

'The material of the dart shall be either of stainless steel or any other material of similar durability'.

(PCD 12)