



## 5.2 Insulation

5.2.1. The insulation shall consist of ethylene propylene rubber and chloro sulphonated polyethylene (Hypalon) conforming to grade FR 1 for 1100 Volt grade cable and FR 2 for 3300, 6600 and 11000 Volt grade cable.

For cables of grade 1100 V and 3300 V, a separator comprising of a layer of 0.025 mm (nominal) thick polyester film tape (Mylar or Melinex) shall be applied between the conductor and insulation.

Whenever specified in the order, the cable can be supplied without polyester film tape (Mylar or Melinex) separator.

For cables of grade 6600 V and 11000 V, the insulation shall be applied over the semi-conducting tape, a layer of which is applied directly over the conductor. The semi conducting tape shall consist of textile fabric proofed with a suitable semiconducting compound. The surface resistivity of the tape shall not exceed 1000,000 ohms per unit square and shall not exceed 0.15 mm in thickness. The tape shall be applied with an overlap of approximately 25% of its width.

The conductor shall be centered accurately in the insulation and it shall be possible to remove the insulation cleanly and without difficulty.

### 5.2.2. Thickness of Insulation :

The average radial thickness of insulation, when determined by the method described in B.S : 6469 shall not be less than the values specified in table III of this specification. However, it is permissible for thickness at any place to be less than the value specified, provided that the difference does not exceed 0.1 mm + 10% of the value specified.

Thickness of Chloro sulphonated polyethylene (Hypalon) shall be of the following percentage of total thickness of insulation.

Voltage Grade	Thickness of hypalon
1100, 3300 & 6600	25 to 50 Percent
11000	20 to 35 Percent

### 5.2.3. Colour :

Unless otherwise specified in the order, the colour of the cable shall be black.

### 5.2.4. Insulation Resistance :

When tested as per IS : 10810 Part 43, the insulation resistance at 20° C shall conform to the following values :

FR 1 (1100 volts)	- 1900 M $\Omega$ km, min
FR 2 (3300, 6600, 11000 volts)	- 3700 M $\Omega$ km, min



**ETHYLENE, PROPYLENE RUBBER INSULATED CABLE**  
(Voltage Grades 1100, 3300, 6600, and 11000 Volts)

**1.0 GENERAL :**

This specification governs the quality requirements of insulated copper cables suitable for voltage grades of 1100 V, 3300 V, 6600 V and 11000 V. The insulation consists of a layer of ethylene Propylene rubber, over which another layer of chloro sulphonated poly-ethylene (HYPALON) is applied.

**2.0 APPLICATION :**

Used for lead connections of electrical machines, switchgear, control gear etc.

**3.0 COMPLIANCE WITH NATIONAL STANDARDS :**

There is no National Standard covering this type of cables However, assistance has been drawn from the following National Standard.

BS : 6195 - 1993, Type 4 : Insulated Flexible Cable Cords For Coil Leads.

**4.0 SIZE AND GRADE :**

The size, dimension and grade of cable shall be as stated in the order. The sizes shall preferably be selected from table III of this specification.

**5.0 MANUFACTURE :**

**5.1 Conductor**

**5.1.1. Material of Conductor :**

The conductor core shall consist of tinned annealed high conductivity copper wires with electrical and mechanical properties in accordance with clause 5 of IS : 8130.

**5.1.2. Resistance of conductor :**

Resistance of each conductor at 20° C shall not exceed the appropriate maximum values as given in Table III.

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Approved: INTERPLANT MATERIAL  
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CS-1028



### 6.3 Solvent Resistance Test :

A specimen of cable shall be heated in air for  $24 \pm 0.25$  hours at a temperature of  $150^\circ \pm 3C$ , and in the hot condition, immersed in xylene at room temperature for  $60 \pm 5$  minutes. The sample shall be withdrawn from the solvent, allowed to dry at room temperature for  $15 \pm 1$  minutes and heated for a further period of  $24 \pm 0.25$  hours at  $150^\circ \pm 3C$ . The Sample shall be allowed to cool to room temperature for  $60 \pm 5$  minutes and then bent through round a mandrel having a diameter as specified in Table I above. The sample shall show no sign of cracks, swelling or other deterioration of the insulation on visual examination and shall withstand the appropriate proof voltage given above in Table II. The test shall be conducted as described in B.S.6195.

### 6.4 Flame Resistance Test :

A sample of the cable  $300 \pm 10$  mm long shall be supported in the horizontal position and shielded from draughts.

The flame of spirit burner shall be applied midway along the length of the sample in such a manner that the cable is in the tip of the visible flame for a period of 30 seconds.

After the removal of the flame, the cable shall not continue to burn for more than 30 seconds and the spread of the flame shall not extend for more than 50 mm on either side of the point of application.

### 6.5. Voltage Test :

A specimen of cable, of suitable length, after removing the insulation at one end and exposing the copper conductor for an electrical connection shall be immersed in water so that the ends are above water, at room temperature for not less than 12 hours. With the cable still immersed in water, a test voltage at 50 Hz a.c., as specified below shall be applied between the conductor and water for a duration of 5 minutes and they shall withstand it without breakdown.

Grade V	Test Voltage, kv, rms
1100	3.0
3300	10.0
6600	18.0
11000	25.0

### 7.0 TEST CERTIFICATES :

Unless otherwise stated, three copies of test certificates shall be supplied along with each consignment.

In addition, the supplier shall ensure to send one copy of test certificates along with their despatch documents/shipping list / packing list to facilitate quick clearance of the material.

The test certificates shall bear the following information.

**6.0 PROPERTIES :****6.1 Bend Test (As Received) :**

A specimen of cable, in as received condition, shall be bent through 180° round a mandrel having a diameter as specified in Table 1 below. The test sample shall not show any sign of crack or other deterioration of insulation on visual examination and shall withstand for one minute the appropriate proof voltage given in Table II. The test shall be conducted as described in B.S. : 6195

**Table : 1 Diameter of Mandrels for Bend Test :**

Conductor size (nominal) mm <sup>2</sup>		Bend Test (As received)	Diameter of Mandrel, mm		
Above	Upto & incl.		Test for effect of Heat Ageing	Solvent Resistant Test	Varnish Resistant Test
	25	1.5 D	2 D	2 D	3.0 D
25	95	2.0 D	3 D	3 D	4.5 D
95	240	2.5 D	4 D	4 D	6.0 D
240	400	3.0 D	5 D	5 D	8.0 D

D = The specified maximum overall diameter of the conductor.

**Table 2 Proof Voltage :**

Voltage Grade	Proof Voltage (a.c.rms)
1100	6.0 KV
3300	15.0 KV
6600	20.0 KV
11000	35.0 KV

**6.2 Effect of Heat Ageing :**

A specimen of cable shall be heated in an oven at a temperature of 150° C ± 3°C for 48 ± 0.5 hours. It is then allowed to cool to room temperature and bent through 180° round a mandrel having a diameter as specified above in Table 1. The sample shall show no sign of crack or other deterioration of insulation on visual examination and shall withstand the appropriate proof voltage given above in Table II, for one minute. The test shall be conducted as described in B.S. 6195.



TABLE III

S.No	Conductor			Radial Thickness of Insulation, mm, min				Maximum overall dia. mm				Max D.C Resistance at 20°C (ohm/km)
	Nom Area mm <sup>2</sup>	Max Dia of each strand mm	Appx Dia of conductor	Voltage grade				Voltage Grade				
				1100	3300	6600	11000	1100	3300	6600	11000	
1.	0.5	0.21	0.93	1.4	-	-	-	4.5	-	-	-	40.1
2.	0.75	0.21	1.14	1.4	-	-	-	4.7	-	-	-	26.7
3.	1.0	0.21	1.32	1.4	-	-	-	4.9	-	-	-	20.0
4.	1.5	0.26	1.60	1.4	-	-	-	5.2	-	-	-	13.7
5.	2.5	0.26	2.00	1.4	2.8	-	-	5.6	8.5	-	-	8.21
6.	4	0.31	2.60	1.4	-	-	-	6.3	-	-	-	5.09
7.	6	0.31	3.60	1.5	-	-	-	7.5	-	-	-	3.39
8.	10	0.41	4.60	1.5	-	-	-	8.5	-	-	-	1.95
9.	16	0.41	5.70	1.5	2.8	5.0	-	9.6	12.4	17.2	-	1.24
10.	25	0.41	7.10	1.6	2.8	5.0	7.6	11.4	13.8	18.6	24.1	0.795
11.	35	0.41	8.50	1.6	2.8	5.0	7.6	12.8	15.2	20.0	25.5	0.565
12.	50	0.41	10.30	1.7	2.8	5.0	7.6	14.8	17.1	22.1	27.3	0.393
13.	70	0.51	12.40	1.8	2.8	5.0	7.6	17.2	19.2	24.2	29.4	0.277
14.	95	0.51	14.50	2.0	3.0	5.0	7.6	19.7	22.0	26.3	31.5	0.210
15.	120	0.51	16.00	2.2	3.0	5.0	7.6	21.9	23.5	27.8	33.3	0.164
16.	150	0.51	18.00	2.3	3.0	5.0	7.6	24.1	25.5	29.8	35.3	0.132
17.	185	0.51	20.00	2.4	3.0	5.0	7.6	26.3	27.5	32.1	37.3	0.108
18.	240	0.51	23.00	2.4	3.0	5.0	7.6	29.3	30.5	35.1	40.3	0.0817
19.	300	0.51	26.00	2.6	3.0	-	-	33.0	33.8	-	-	0.0654
20.	400	0.51	30.00	2.8	3.0	-	-	37.4	37.8	-	-	0.0495

**CORPORATE PURCHASING SPECIFICATION**

A A 285 42

REV. No. 03

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AA 28542 (Rev.No.03) : Ethylene, Propylene Rubber Insulated Cable

BHEL Order No.

Manufacturer's / supplier's Name

Batch / Lot No.

Grade / Trade Mark, if any

Date of manufacture

Test Results for all the properties and dimensional tolerances as per the specification.

**8.0 PACKING AND MARKING :**

The material shall be supplied in drums or coils or reels in continuous lengths suitably packed to prevent damage during transit. Each drum shall bear the following information.

AA 285 42 : Ethylene, Propylene Rubber Insulated Cable

BHEL Order No.

Manufacturer's / Supplier's Name

Batch / Lot No.

Grade / Trade mark, if any

Quality supplied

Date of manufacture

**9.0 REFERRED STANDARDS ( Latest Publications Including Amendments )**

1. BS : 6195
2. BS : 6469
3. IS : 8130
4. IS : 10810 Part 43.