



TSD 6206 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 1 OF 6

**SUPERSEDES
BP 22861 Rev.11**

AXIALLY ORIENTED POLYPROPYLENE FILM FOR CAPACITORS

1.0 GENERAL :

This specification governs the quality requirements of balanced bi axially oriented Polypropylene film for use as a capacitor dielectric having good resistance to dilute acids, alkalies, greases, oils and fats.

2.0 APPLICATION :

Used as dielectric for power, coupling & surge capacitors.

3.0 COMPLIANCE WITH NATIONAL STANDARDS :

The material shall generally comply with the requirements of IS:11298 (Part 3/ Sec.1) -1991, IS Reaffirmed 2015 Specification for Plastic Films for Electrical Purposes. Part 3 Specification for Individual Materials, Sec.1 Polypropylene Film for Capacitors. Reaffirmed 2005.

4.0 DIMENSIONS & TOLERANCES :

Thickness: By weight method (Annexure - II)

Shall be stated on our order. Unless otherwise stated, all the thicknesses referred in this specification are weight thickness only. The standard thickness and tolerance shall be as follows :

Nominal Thickness (Micron)	Tolerance
9.0	±6%
10.0	±6%
11.0	±6%
12.0	±6%
14.0	±6%
15.0	±6%
16.5	±6%
18.0	±6%

Revision :
Reviewed & IS Reaffirmed 2015

Issued by :

STANDARDS AND MATERIALS GROUP
TECHNICAL SERVICES DEPARTMENT

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TSD 6207 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 2 OF 6

4.1 Width :

Shall be stated on our order. Tolerance shall be as below

Film width	Tolerance
Upto 150 mm	0.75
Above 150 mm	1.50

"The width shall be measured with a steel ruler having 0.5mm graduation after laying 5-meter sample, by folding it at an approximate distance of one meter on a flat surface for one hour. Average of ten readings at equal distance is the width of the film".

5.0 MANUFACTURE :

5.1 Resin :

The film shall be manufactured from virgin and special grade polypropylene resin for achievement of highest possible dielectric performance.

5.2 Surface / Finish :

Film surface shall be clean and non-blocking. Optical properties shall be consistent from lot to lot. The surface structure allows the penetration of the impregnate into the capacitor windings resulting in complete impregnation.

5.3 Defects :

The film shall be free of particulate matter, blisters, holes and wrinkles so as to be functionally acceptable.

5.4 Orientation :

The film shall be fully oriented with essentially balanced physical properties.

5.5 Break/Joint :

Maximum one break/joint per roll is permitted. The Joint/break shall be overlapped & suitably indicated at both ends.

6.0 TEST METHODS : As stated against each clause.

7.0 PHYSICAL PROPERTIES :

7.1 Camber

A 1.5-meter length of film shall not deviate from a straight line by more than 3 mm when laid flat on a smooth surface.

7.2 Shrinkage at $100 \pm 2^\circ\text{C}$ for 10 minutes (%) - ASTM. D-1204

MD: 4.0, Max,
CMD: 1.5, Max.



TSD 6207 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 3 OF 6

7.3 Space Factor :

6 to 10 % - below 10 microns P.P. Film

7 to 13 % Above 10 microns P.P. Film

$$\text{Space Factor} = \frac{\text{TKm} - \text{TKw}}{\text{TKw}} \times 100$$

TKm = Thickness by micrometer method. (As per Annexure - I)

TKw = Thickness by weight method. (As per Annexure -II)

8.0 **CHEMICAL PROPERTIES** : (TYPE TEST)

Identification :

When identified by Infra-Red Spectrophotometer or any other method, the material shall conform polypropylene film.

9.0 **MECHANICAL PROPERTIES** :

9.1 Tensile Strength : (ASTM: D-882)

Machine Direction (MD) : 110 N/mm², Min.Cross-Machine Direction (CMD) : 140 N/mm², Min.9.2 Tensile Strength MD / CMD Ratio : 0.40 to 1.209.3 Elongation at Break : 40% Min.

10.0 **ELELCTRICAL PROPERTIES** :

The dielectric strength (BDV) of the film shall be measured either by A.C. or D.C. as indicated below.

(i) A.C. Measurement : (Annexure - III)

Thickness (Micron)	Breakdown voltage (Average) A.C.
9 to 15	300/mm
16 to 18	315 kV/mm

(ii) Alternatively, D.C. Measurement as per IS:11298

Thickness (Micron)	Breakdown Voltage (Average) D.C.
9 to 11	400 kV / mm
12 & above	525 kV/mm



TSD 6207 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 4 OF 6

11.0 TEST CERTIFICATE :

a) The supplier shall submit a certificate of test showing conformance to this specification on representative samples from a shipment and as well as the type test reports of the following typical properties at the time of dispatch. The type test shall be conducted once in each 5 years and copies shall be submitted with every consignment. In the certificate the specification and purchase order number shall be mentioned.

b) Type test requirement :

Volume Resistivity : 10 16 Ohm-cm, Min (ASTM D-257)

Dielectric Constant : 2.2 to 2.3 (ASTM D-150)

Power Factor at 100°C : 0.09%, Max. (ASTM D-150)

12.0 THICKNESS VARIATIONS AND ROLL BALANCING SYSTEM :

The thickness is determined as roll average thickness based on roll weight, film length and film width measurements. The rolls are then classified according to thickness into three tolerance groups:

Nominal Thickness μm	Tolerance group for balancing		
	-	0	+
9.0	8.5-8.7	8.8-9.2	9.3-9.5
10.0	9.5-9.7	9.8-10.2	10.3-10.5
11.0	10.5-10.7	10.8-11.2	11.3-11.5
12.0	11.5-11.7	11.8-12.2	12.3-12.5
14.0	13.5-13.7	13.8-14.2	14.3-14.5
15.0	14.5-14.7	14.8-15.2	15.3-15.5
16.5	16.0-16.2	16.3-16.7	16.8-17.0
18.0	17.5-17.7	17.8-18.2	18.3-18.5

The film shall be fully balanced & the supply is accepted provided

- (i) The bobbins shall be marked as given above.
- (ii) For each nominal thickness, equal number of + and -ve bobbins are packed together.
- (iii) Bobbins with 'O' group tolerance balancing is not required & shall be packed separately.

Equal number of + and - designated bobbins (e.g. + 11 & -11) shall be packed in super carton & vertically separated by a piece of cardboard.



TSD 6207 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 5 OF 6

13.0 PACKING & MARKING :

13.1 Marking of Rolls :

Each roll has a roll label on the outer surface of the roll and as well as on the inner side of core.

The label shall give following information:

Supplier's Name.....

Lot No..... Width mm.....

Nom thickness μLength m

Av thickness μ Balancing (0 or \pm)

Weight kg Pack No

13.2 PACKING OF ROLLS :

The rolls shall be suitably packed to prevent damage and contamination during transit and storage.

The package shall be marked with the following

BP 22861 : Bi-axially oriented Polypropylene Film for Capacitors.

BHEL Order No.

Supplier's and Manufacturer's Name.

Identification Code.

Thickness and Width.

Date of Manufacture.

Net weight of film.

13.3 Core & Roll Diameter :

Core diameter : 76 mm

Max. roll diameter : 220 mm (ABOVE 220 mm NOT ACCEPTABLE)

Width of the film : 310 mm or As specified in purchase order.



TSD 6207 A

PLANT PURCHASING SPECIFICATION BHOPAL

BP 22861

Rev. No. 12

PAGE 6 OF 6

ANNEXURE – I

THICKNESS BY MICROMETER METHOD

Ten samples of polypropylene film are cut using a template of 170 x 100 mm size. These samples are stacked and thickness of this stack is measured accurately with a micrometer. Length of the test sample shall be cut across the width of the roll. 10 readings are taken across the length and width of the sample. Micrometer thickness shall be computed from the average of 10 readings.

This shall be used for computation of space factor.

ANNEXURE – II

THICKNESS BY WEIGHT METHOD

Ten samples of polypropylene film are cut using a template of 170 x 100 mm size. Length of the test sample shall be cut across the width of the roll. These samples are stacked and accurately weighed together. The thickness of the film is then calculated by the formula

$$t(u) = \frac{W}{0.1538}$$

W = measured weight of 10 samples in gms.

This thickness shall be used for computation of space factor.

ANNEXURE – III

MEASUREMENT OF DIELECTRIC STRENGTH OF POLYPROPYLENE FILM

This is determined by taking a sample of polypropylene film of suitable length, laying it flat on an aluminum foil. Then by using a copper electrode of 25 mm dia and 15 mm height as the upper electrode. The aluminum foil used as lower electrode is connected to the earth. A sinusoidal a.c. voltage of 50 Hz is gradually applied till breakdown occurs. An average of 10 such readings are taken.

MANUFACTURING QUALITY PLAN

Sr. No.	Components/ Operation & Description or Test	Type of check	Quantum of check/ Sampling With basis	Reference Document for Testing	Acceptance Norms	Format of records	Applicable Codes						Remarks	
							1	2	3	4	5	6		
	BHEL BHOPAL	Customer	Vendor Code	Item	QP. No.:	Rev. No.	Rev. Date	Valid from	Valid up to	Page				
		POWERGRID	23E2 D2	H.T CAPACITOR (SERIES&SHUNT)	CAB 111	04	14.07.2011	01.07.2011	30.06.2014	1				

SECTION: RAW MATERIAL INSPECTION

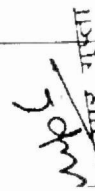
1.1	STAINLESS STEEL SHEET											
1.1.1.	Visual & Dimensional checks		One sample per lot for each size	BHEL Specn. CPE/PS/8018/04 /Electrical specn. / POWERGRID Specn.	CMTC		B	K	P	W	N	Surveillance check by PowerGrid for review of BHEL records/Mfr. TC
	a) Visual check		--DO--	Free from defects No. damage.			B	K	P	W	N	--DO--
	b) Thickness		--DO--	CPE/PS/8018/04 /			B	K	P	W	N	--DO--
	c) Width		--DO--	CPE/PS/8018/04 /			B	K	P	W	N	--DO--
	d) Length		--DO--	--DO--			B	K	P	W	N	--DO--
	e) Straightness (Camber)		--DO--	--DO--			B	K	P	W	N	--DO--
	f) Flatness		--DO--	--DO--			B	K	P	W	N	--DO--
1.1.2	Check for											
	a) Chemical composition		--DO--	--DO--			B	K	P	W	N	--DO--
	b) Mechanical properties.		--DO--	--DO--			B	K	P	W	N	--DO--
	c) Surface finish		--DO--	--DO--			B	K	P	W	N	--DO--
1.2	HAZY POLYPROPYLENE FILM										E	
1.2.1	Visual & Dimensional checks				CMTC		B	K	P	W	N	
a)	Visual check & classification of rolls for thickness balancing (To be done during element winding stage when rolls are unpacked)		IS:2500 AQL= 4% Lot Sample Size Size 2 to 90 3 91 to 280 13 281 to 500 20 One sample	BHEL Specn. BP22861 / BHEL Electrical specn. POWERGRID Specn. No. damage			B	K	P	W	N	Surveillance check by PowerGrid for review of BHEL records/Mfr. TC
b)	Width			--DO-- Film Width Tol. Upto 150 +0.75mm >150 +1.50mm			B	K	P	W	N	--DO--
c)	Thickness by weight method		One sample per lot for each size.	--DO -- Tol. ± 6%			B	K	P	W	N	--DO--

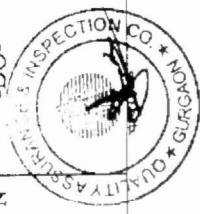
उपर
 श्री. प्रकाश गुप्ता
 रक्त प्रबंध (गुआ)
 श्री. आश्विन-टी.सी.बी.
 श्री. एच.ई.एल. मोपास



MANUFACTURING QUALITY PLAN

BHEL BHOPAL		Customer	Vendor Code	Item	QP. No.:	Rev. No.	Rev. Date	Valid from	Valid up to	Page				
POWERGRID			23E2 D2	H.T CAPACITOR (SERIES&SHUNT)	CAB 111	04	14.07.2011	01.07.2011	30.06.2014	2				
Sr. No.	Components/ Operation & Description or Test	Type of check	Quantum of check/ Sampling With basis	Reference Document for Testing	Acceptance Norms	Format of records	Applicable Codes						Remarks	
							1	2	3	4	5	6		
d)	Camber				-DO - Max. 3mm for 1.5 meter length			B	K	P	W		N	-DO-
1.2.2	Check for -													
a)	Shrinkage		One sample per lot for each size.		-DO - 4% Max in MD (Machine Direction) 1.5% Max in CMD (Cross Machine Direction) at 100 deg. C+ -2deg. C for 10 minutes			B	K	P	W		N	-DO-
b)	Space Factor		One sample per lot for each size.		BHEL Specn. BP22861 / BHEL Electrical specn / POWERGRID Specn Below 10 micron: 6 to 10% Above 10 micron: 7 to 13%			B	K	P	W		N	Surveillance check by Power Grid for review of BHEL records/Mfr. TC
c)	Tensile Strength		-DO -		-DO - 110 N/mm ² min. In MD & CMD 140 N/mm ²			B	K	P	W		N	-DO-
d)	MD to CMD ratio of Tensile Strength		-DO -		-DO - 0.4 to 1.20			B	K	P	W		N	-DO-
e)	Elongation at break		-DO -		-DO - 40%min.			B	K	P	W		N	-DO-
f)	Electrical Properties - Dielectric strength (AC OR DC)		One sample per lot for each size.		-DO - Thickness (micron) 9 to 15 16 to 18 Thickness BDV (DC) 9 to 11 12 & above BDV(AC) kV/mm 300 315 BDV (DC) 400 525			B	K	P	W		N	Surveillance check by Power Grid for review of BHEL records/Mfr. TC
JCTT														
Volume Resistivity (Type test)			One sample for each size. Once in 5 yrs. for every supplier		-DO - 1 x 10 ¹⁶ ohm cm Min.			B	K	P	W		N	-DO-
JCTT														


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 आरवाशन-टी.सी.बी.
 एच.ई.एल. भोपाल



MANUFACTURING QUALITY PLAN

Sr. No.	Components/ Operation & Description or Test	Type of check	Quantum of check/ Sampling With basis	Reference Document for Testing	Acceptance Norms	Format of records	Applicable Codes						Remarks
							1	2	3	4	5	6	
	BHEL BHOPAL	Customer	Vendor Code	Item	QP. No.:	Rev. No.	Rev. Date	Valid from	Valid up to	Page			
		POWERGRID	23E2 D2	H.T CAPACITOR (SERIES&SHUNT)	CAB 111	04	14.07.2011	01.07.2011	30.06.2014	3			

h)	Dielectric Constant at 50 Hz (Type test)	-DO -	-DO -	-DO - 2.2 to 2.3		B	K	P	W	N		Surveillance check by Power Grid for review of BHEL records/Mfr. TC
		-DO -	-DO -	-DO - 0.09% max		B	K	P	W	N		-DO-
		-DO -	-DO -	-DO - Should be polypropylene		B	K	P	W	N		-DO-
					CMTc					E		
1.3	ALUMINIUM FOIL HIGH PURITY											
1.3.1	Visual & dimensional checks					B	K	P	W	N		Dent free/Rinse free foil to be used
a)	Visual checks -		Lot Sample size 2 to 90 - 5 91 to 280 - 13 281 to 500 - 20	BHEL specn. BP12399 POWERGRID Specn. No. damage		B	K	P	W	N		Surveillance check by PowerGrid for review of BHEL records/Mfr. TC
b)	Width		--DO--	+0.4 mm		B	K	P	W	N		-DO-
c)	Thickness		One sample per lot for each size.	--DO-- + 10% of normal thickness		B	K	P	W	N		-DO-
1.3.2	Check for -											Surveillance check by Power Grid for review of BHEL records/Mfr. TC
a)	Chemical composition		One sample per lot for each size.	BHEL spec. BP12399 POWERGRID Specn. 99.35% Min (Al) 0.65% max. (balance)		B	K	P	W	N		-DO-
	i)Aluminum											
	ii)Total impurities including iron & silicon											

वरिष्ठ निरीक्षक (मुआ.)

 प्रबंधक (मुआ.)

 आश्वासन-टी.सी.

 एच.ई.एल.मोनाल

