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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION
FOR
RESIN PRE-IMPREGNATED SEMI-CURED UNIDIRECTIONAL

GLASS BANDING TAPE

FOR USE ON TRACTION MOTORS
OF
ELECTRIC LOCOMOTIVES AND EMUs

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SPECIFICATION FOR RESIN PRE-IMPREGNATED SEMI-CURED UNIDIRECTIONAL **GLASS BANDING TAPES** FOR USE ON TRACTION MOTORS OF ELECTRIC LOCOMOTIVES AND EMUS

1. SCOPE

This specification covers the requirements and supply of Resin pre-impregnated semi-cured unidirectional glass banding tapes (also called as "Polyglass tape" or "Resiglass tape" by some manufacturers) for traction motors of Electric Locos/EMUs. The product shall be referred to as "Glass Banding Tape" in the specification hereafter.

2. REFERENCES

S.No.	Specification/standards	Description
1	ISOLA	Polyglass H220 Banding tape thermal class 200 moisture resistant
2	JIS K6911-1979 (Re-affirmed in 1995)	Testing Methods for Thermosetting Plastics
3	BHEL specification no. BP 25792 Rev 02	Unsaturated polyester resin pre-impregnated uni-directional glass tape
5	CLW specification no. 4TMS.092.057A	Polyglass tape impregnated with epoxy resin
6	RDSO MP directorate specn. MP.0.24.00.23(Rev00) March 2001	Specification of class 200 resin-pre-impregnated polyglass banding tapes used on traction machines (TG/TM/AG) of Diesel electric locomotives/diesel electric multiple units.
7	DCW Specn no. 4/DCW/specn./TM-008 of March 1992	Glass banding tape (Acrylic resin impregnated weftless glass tape)
8	Hitachi specn. A0126	Glass binding tape impregnated with epoxy resin
9	Hitachi specn. A0247	Glass binding tape
10	CLW specn. 4TMS.095.021 Issued 24.8.94,Alt 1 of 28-01-97	Specification of "C" class resin impregnated glass binding tapes
11	IS 15208-2002 of Sep 2002	Unidirectional non-woven semi-cured glass fibre tape- specification
12	BS 2782 Part-10 method 1006-1978(Re-affirmed 1995)	Method for determination of volatile matter & resin content of synthetic resin-impregnated textile glass fabric
13	IEC 60455-2-1977 second edition 1998	Resin based reactive compounds used for electrical insulation.
14	IS : 1998-1962 as amended	Methods of test for Thermosetting Synthetic Resin Bonded Laminated Sheets

3.0 GENERAL REQUIREMENTS

3.1 The glass yarns used shall be continuous glass fibres (usually known as E glass, containing not more than one percent of alkali calculated as sodium oxide and shall be impregnated with catalysed thermosetting synthetic resins like acrylic/polyester, etc. meeting desired thermal class for specific application and semi-cured to a suitable stage to ensure desired flow characteristics during applications like bandaging of armature of electrical machines, transformers coils, etc. to retain windings/assemblies in position.

3.2 The glass banding tape shall be supplied in semi-cured stage in rolls in soft well-balanced flat ribbon without any separation of yarns and distortion, ensuring that each yarn bears equal share of load after application. It should be easily unwindable.

3.3 The glass banding tape shall have a temperature index of 200 °C.

4. APPLICATION

4.1 Glass Banding tape is used for banding of armature of 'H' and 'C' class traction motors used on Electric Locos/ EMUs. This Glass banding tape shall be capable of retaining the armature coils in position against the centrifugal forces experienced during service.

4.2 The banding shall be done on the preheated armature only so that resin of the tape should flow between layers and forms a homogenous mass, when cured.

4.3 During banding, the maximum pull on the banding tape shall not exceed 100 kgf/cm of width.

5.0 NATURE OF RESIN AND RELATED TAPE CHARACTERISTICS

5.1 Identification of Resin: Chemical composition of resin binder as determined by Infra-red Spectrograph or thin layer chromatography or any other suitable method to determine whether it is acrylic or polyester resin.

5.2 Curing Of Resin After Application: The minimum curing time required to get good consolidation after applying on the job (object) shall be 5 hours at a steady job temperature of 150 °C. The time necessary to bring the job to curing temperature shall be extra. After curing, the surface shall be tack free and layers shall not get separated easily.

6. CHARACTERISTICS OF GLASS BANDING TAPE

6.1 DIMENSION AND TOLERANCE

TABLE - I

S.No.	Description	Acceptable limits	Clause no. of test procedure	Nature of tests	
				Type	Acceptance
1	Thickness(in mm)	0.33 + 0.05	8.1	YES	YES
2	Width (in mm)	Upto 25 ± 1.5 Above 25 ± 2.0	8.2	YES	YES
3	Nominal length of Roll (in m.)	200+ 5 - 0	8.3	YES	YES

6.2 CHARACTERISTICS AS SUPPLIED

TABLE - 2

S. No	Description	Acceptable limits	Clause no. of test procedure	Nature of tests	
				Type	Accept -ance
1	Resin content (%)	27+ 2	8.4	YES	YES
2	No. of yarns/cm of width	30+ 1	8.5	YES	YES
3	Sealing (solder) Test	The resin of the tape should flow and stick to other layers within one minute.	8.6	YES	YES
4	Koeffler's softening point of resin (Max.)	235 °C	8.7	YES	YES
5	Mass/100 m of 10 mm wide tape (in kg.)	0.56 (Approx.)	8.8	YES	YES
6	Tensile strength (N/mm of width) (Min.)	250	8.9	YES	YES
7	Curing test	Surface should be tack free and layers should not get separated easily.	8.10	YES	YES
8	Weight loss (%) (Max.) (at 200 °C for 400 hrs.)	10	8.11	YES	NO
9	Identification of Resin	Polyester or Acrylic resin	5.1	YES	YES

6.3 CHARACTERISTICS AFTER APPLICATION AND CURING

TABLE - 3

S. No	Description	Acceptable Limits	Clause no. of Test Procedure	Type	Acceptance
1	Breaking Load (N/mm width)				
	- At room temperature (min.)	265 N/mm width	8.12	YES	YES
	- At 150 °C after heat ageing (Min.)	185 N/mm width		YES	NO
2	Elongation at break		8.13		
	- at 20 °C (Max.)	1.6 %		YES	YES
	- at 200 °C (Max.)	2.0 %		YES	NO
3	Humidity Resistance	Should pass the test	8.14	YES	NO
4	Saline water Resistance	Should pass the test	8.15	YES	NO
5	Moisture Resistant Test / Cross breaking Strength N/mm^2, Min.		8.16		
	- At Room Temperature	900.00 N/mm^2		YES	YES
	- At room temperature after boiling in water for 14 days	50% max. reduction of the As received value		YES	NO
6	Arc Resistance	> 120 sec	8.17	YES	YES

7. Testing

7.1 The tests to be carried out on banding tape samples are classified as follows:

(a) **Type Tests:** To be carried out on prototype samples of banding tape of given design.

(b) Acceptance Tests: To be carried out by the manufacturer at the time of acceptance of supplies. All the tests as specified in this specification shall be carried out on sample roll and lot shall be accepted subject to test results being in the permissible range.

7. The type tests and acceptance tests to be carried out on the samples are enlisted in the clauses 6.1,6.2 and 6.3. The detailed test methods are provided in paras of Clause 8.

7. Pre-treatment of test specimens:

7.1 The specimens shall be kept at room temperature for at least 2 hours before carrying out of tests.

7.2 Before carrying out tests on test sample, at least two (2) turns of outer side of specimen subjected to pre-treatment, shall be de-taped and discarded.

8. TEST METHODS

The tests are Classified as:

(A) Tests on as supplied tape, described in clause 8.1 to 8.11; and
(B) Tests on tape after application and curing, described in clause 8.12 to 8.17.

(A) TESTS ON AS SUPPLIED TAPE

8.1 MEASUREMENT OF TAPE THICKNESS

8.1.1 Test Appliance: Micrometer having accuracy of 0.01 mm

8.1.2 Test Pieces: Take 5 rolls of tape selected at random.

8.1.3 Conditioning: Condition the tape rolls to moisture equilibrium in atmosphere of relative humidity of 65 ± 2% with temperature 27 ± 2 ^{0}C (See IS 196) before testing.

8.1.4 Test Procedure: Pressure exerted when measuring thickness be of order of 10 N/cm^2 From each roll measure the thickness of tape every 300 mm. Take 10 measurements.

8.1.5 Result: Take the average of ten measurements on each roll. Take the central value of five individual results as thickness of tape.

8.2 WIDTH OF TAPE

8.2.1 The specimen shall be placed on a flat bed and the width shall be measured using the scale with 0.5 mm scale at 5 locations with the spacing of about 300 mm without applying tension. Their mean value shall be obtained.

8.3 LENGTH OF TAPE

8.3.1 Take net weight of 1 (one) roll (P1) on a weighing machine with 1 gm accuracy. Then cut three pieces of tape of exact 1 meter length from that roll. Weigh the three tape pieces individually on a weighing machine of 0.001 gm accuracy and the arithmetical mean of the three values should be obtained (P2) which represents the average weight of the tape per linear metre. The length of the tape can be obtained by P1 / P2

The length of specimen shall be measured using a suitable length-measuring steel scale without applying tension.

8.4 RESIN CONTENT

8.4.1 Test Specimen: Three pieces of 1m length each cut from the roll at random

8.4.2 Conditioning: Condition the test pieces at prevailing ambient temperature for one hour .

8.4.3 Test Procedure : Weigh the specimen in porcelain/ceramic dish/crucible (P1). Heat it in an oven at a temperature of 600 ± 25 ° C for 2 h. Cool the crucible in a desiccator and weigh after it has returned to room temperature to determine the weight of residue (P2).

8.4.4 Result : Resin content percent = $\frac{P1 - P2}{P1} \times 100$

The arithmetical mean of the values is obtained.

8.5 MEASUREMENT OF NUMBER OF YARNS/CM OF WIDTH

8.5.1 After having burnt the tape ends, count number of yarns. To estimate number of yarns/cm. of width, use nominal tape width.

8.6 SEALING (SOLDER) TEST

8.6.1 Test Piece : A roll of the tape

8.6.2 Procedure : A solder iron at 160 ± 2 °C pressed on the top layer of the roll. The resin of the tape should flow and stick to other layers within one minute.

8.7 PROCEDURE FOR THE DETERMINATION OF SOFTENING AND CURE INITIATION TEMPERATURE OF BINDER USED IN GLASS BANDING TAPE BY KOEFFLER APPARATUS

8.7.1 Summary of the Method

This procedure deals with the determination of temperatures at which the binder of glass banding tape begins to soften and starts converting into infusible state. The method consists of placing 2 layers of the tape on the heated surface of Koeffler apparatus for a specified period under a fixed load and then observing its condition.

8.7.2 **Apparatus:**

i) Koeffler Apparatus (IEC 455-2)

ii) Metallic Weights.

iii) Aluminum sheet padded on one side with rubber.

iv) Aluminum foil of 0.025 mm thick.

v) Set of calibration compounds.

8.7.3 **PROCEDURE**

Switch on the apparatus and allow stabilising for 45 to 60 minutes. Calibrate the temperature of apparatus with pure substances of known melting points. Place two test pieces of tape equal in length to that of the hot plate over each other and sandwich them between aluminium foil.

Place the tape and foil on the hot plate and immediately place aluminium sheet with rubber facing the foil and required weight to give a pressure of 60 g / cm^2 on the test piece. Allow the test piece to be on hot plate for a period of 20 seconds. Remove the test piece from the plate. Remove the aluminium foil and starting from cold end, try to separate the pieces of tapes. Mark the point at which first sign of sticking between two pieces of tape (the layers of tape do not get separated easily and there is transfer of resin from one layer to another). Continue to separate the tapes till it is no longer possible to do so without breaking one of the layers. Mark this point also. Measure the distance of these two points from cold and read corresponding temperature on the hot plate.

Take the average of three readings. If there is a difference of more than 3 °C between two readings, repeat the tests on two more samples.

8.7.4 **Test Report of the Results:**

8.7.4.1 Temperature for initial softening : Degree C.

8.7.4.2 Temperature for attaining infusible state (Softening Point) – Degree C.

8.7.5 It may sometimes be necessary to apply a releasing agent in the aluminium foil. Silicone grease is suitable for this purpose.

8.1.6 Allow the apparatus to return to steady state after making test. 10 to 15 minutes waiting time is usually adequate.

8.1.7 Some times it has been found that the pieces stick together at temperature less than 50 °C. Report initial softening temperature to be less than 50 °C.

8.8 MASS/100 M OF 10 MM WIDE TAPE (in kg.)

8.8.1 Three 1 metre long test pieces are cut from the tape roll & are weighed, the arithmetical mean of the three values thus obtained, represents the average weight of the tape per linear metre. The proportionate value of mass/100m of 10 mm wide tape may be calculated.

8.9 TENSILE STRENGTH

8.9.1 TEST PIECE : The test is carried out on a tape of ordered width. Cut the tape first into five 400 mm long test pieces and the remaining tape length into small , 20 mm long pieces. Stretch out carefully the 400 mm long tapes on a horizontal plane. Place the small pieces crosswise, under and over the tape ends at a distance of 300 mm **(FIGURE 1).**

Insert the overlapping ends between two sheet copper or aluminium pieces and cure the resin for 3-5 min by means of an iron heated at a temperature of 200-250 °C.

This procedure will produce a test specimen to be fixed between the clamps of tensile testing machine, with a uniform effort being exerted on the glass yarn.

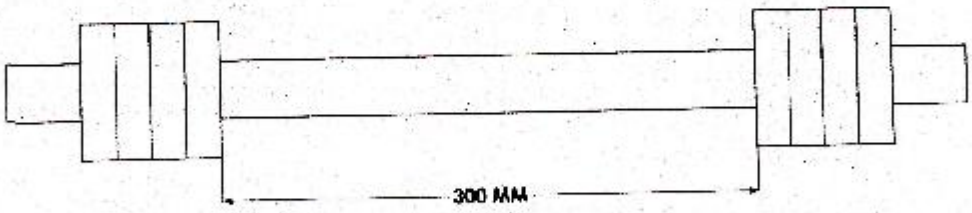


FIGURE – 1

8.9.2 TEST PROCEDURE : Fit the test specimen carefully between the clamps of a tensile testing machine and determine the breaking stress by applying a force which increases gradually without sudden stresses in such a way that breaking occurs after about approximately 30 seconds.

8.9.3 RESULT : Tensile strength is expressed in N/mm. The tensile strength of the tape is the average value of the 5 measurements.

8.10 CURING TEST

8.10.1 Test Piece: A machined steel mandrel of diameter at least 50 mm and length minimum 150 mm.

8.10.2 Procedure: Six layers of tape shall be wrapped tightly on the steel mandrel, the tape being maintained under tension till the band end is sealed with a heat gun or soldering iron. The taped mandrel shall be cured at 150 °C for 5 hours. After cooling the mandrel to room temperature, the cured tape has to be checked for consolidation. Surface should be tack free and layers should not get separated easily.

8.11 MEASUREMENT OF LOSS IN WEIGHT

8.11.1 Test Specimen : Three 1 m long test pieces are cut from one roll at random.

8.11.2 Test Procedure : Weigh (P1) the specimen in porcelain/ceramic dish/crucible. Heat it in an oven temperature higher than the thermal class by 20 deg. C for 400 h ± 30 min. Cool the crucible in desiccator and weight (P2) after it has been returned to room temperature

8.11.3 Result :

$$\text{Weight loss, percent} = \frac{P1 - P2}{P1} \times 100$$

The arithmetic mean of the 3 values is obtained.

(B) TESTS ON TAPE AFTER APPLICATION AND CURING

8.12 METHOD OF TEST FOR BREAKING LOAD OF FULLY CURED TAPE

8.12.1 **Preparation of test specimens:** Three split disc rings of 125 mm dia and having a circumferential groove of 3 mm depth and 25 mm width are banded with six turns with initial and final turns having extra half turn (overlap) so that full six turns are available for breaking load test.

8.12.2 The tape is laid in the groove in a smooth, flat manner such that the centre line of the tape coincides with the centre line of the groove. Tension of maximum 100 N/mm , consistent, throughout the banding operation, is applied to the tape. The tape is maintained under tension till the tape end is sealed with a heat gun.
The bands are cured for 5 hours at 150 ^{0}C.

8.12.3 **Determination of Breaking Load at Room Temperature :**

The bands are broken on a suitable tensile testing machine, the breaking load of each band being recorded. The breaking load of the tape is calculated as under :

P = F/2T X B , where

P - Breaking load in N/mm width of the tape.
F - Average of the breaking loads of the six bands in N.
T - Number of turns of tape per disc ring, (i.e. 6)
B - Width of the tape in mm.

The elongation can also be measured at breaking loads.

8.12.4 **Determination of Breaking Load at 150 ^{0}C after heat ageing :**

Five split disc specimens banded with the tape are prepared as per Clause 8.12.1 & 8.12.2 above. All the samples shall be kept in an oven maintained at 200 degree C. Every second day (i.e. after 48 hours) one sample shall be taken out and tested for Breaking Load as per Clause 8.12.3 above, but at 150 degree C. Thus, the last sample shall remain in oven for 240 hours (10 days) at 200 degree C. A curve shall be plotted showing the fall of breaking load at 150 degree C and Ageing Time (days) at 200 degree C. The strength at any point should not be less than 185 N/mm width i.e. 70% value of Breaking Load at Room Temperature.

8.13 ELONGATION AT BREAK

8.13.1 Prepare the test specimen as per clause 8.12 then place the disc on tensile testing machine, measure the initial disk aperture in the centre after having applied an initial load of 1000N. Thereafter apply the load till reaching breaking load . The specified braking load is 265 N/mm per width. Stop the machine at specified breaking load and measure the final disk aperture in the centre of disk in mm. The difference between initial and final reading is Δl = Disk aperture. This method is preferable.

OR

By plotting on the axis of X-axis of the graph the tensile loads applied and on the Y-axis the readings of the disk aperture multiplied by 2, it is possible to determine the elongation of the tape corresponding to the breaking stress.

Knowing the disk diameter (ϕ 125 mm.) , the elongation in % will be

$$\varepsilon = \Delta l \cdot 100/125\,\Pi$$

where
ϵ = elongation in %
Δl = disk aperture multiplied by 2, in mm.
125 Π = circumference of the disk having a 125 mm. Dia. (initial banding length)

8.14 HUMIDITY RESISTANCE TEST

Two split discs are banded with six layers of tape and cured as per Clause 8.12.1, 8.12.2. One sample partially and the other fully immersed in boiling water for 120 hours. After the test, the band shall be examined visually, there should not be any sign of cracks, damages or any defects on the bands.

8.15 SALINE WATER RESISTANCE TEST

Two split discs are banded with three layers of tape and cured as per Clause 8.12.1,8.12.2. The samples shall be kept in two separate plastic bags containing 3% Sodium Chloride solution by weight. The bags shall be kept at 50 ± 2 degree C for 10 weeks. After the above test, the band shall be examined visually, there should not be any sign of cracks, damages or any defects on the bands.

8.16 MOISTURE RESISTANT TEST (CROSS-BREAKING STRENGTH TEST)

The test consists in determining the flexural strength of Polyglass laminate at room temperature and after keeping in boiling water for 14 days. It shall be carried out on test pieces 20mm wide x 100mm long x 4mm thick obtained from 15 overlapped layers of Polyglass tape then cured.

8.16.1 Test preparation :

First condition the tape in an air oven at 50 °C for 3 hours. Then, cut the quantity of tape necessary to obtain 4 test pieces of Size : 20 mm wide x 220 mm long x 4 mm thick. Put 15 overlapped tape layers in each mould slot and press over each other at (as shown in Figure below).

Tape layers must be protected by a release Polyester film 0.05 mm thick cut in strips of 45 x 200 mm. Film in excess must be taken off by means of a sharp blade.

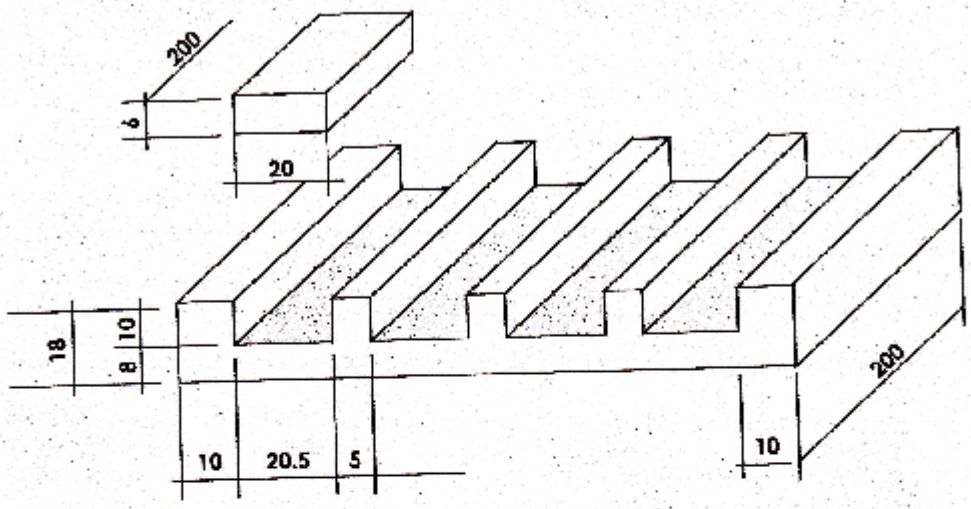
Place the mould between press plates, heated at 155 °C (a 5 mm thick paper matress shall be inserted between mould and plates) and cure at 150 °C for 5 hours.

Let it cool at room temperature, while keeping under pressure. Remove the test pieces.

Now, cut each test piece into 2 halves length wise so that 8 test pieces of Size : 20 mm wide x 100 mm long x 4 mm thick can be obtained.

Lay the test specimen symmetrically across two parallel V shaped supports with tip having radius of 3 m with original face of the sheet in contact with supports. Keep the distance between the supports = 16 times the measured thickness of the test piece. Apply a load uniformly across the width of the test piece by means of 3rd V shaped block parallel to a midway between the supporting blocks. The traverse speed of the machine shall be approximate 25 mm/min. Note the load at fracture.

Unit: mm



8.16.2 Test Method : Cross breaking strength is measured at room temperature on 20 mm wide x 100 mm long x 4 mm thick laminates.. The cross breaking strength is calculated as per the formula given below which is reproduced from IS 1998 :1962

Cross-Breaking Strength, $N/mm^2 = 1.5\ WL/BD^2$

where
W= load at fracture in N
L= distance in mm between supports (16 times of measured thickness of test piece)
B=Breadth in mm of test piece, and
D= Thickness in mm of test piece

Mean of the 3 measurements is taken as the Cross Breaking Strength.

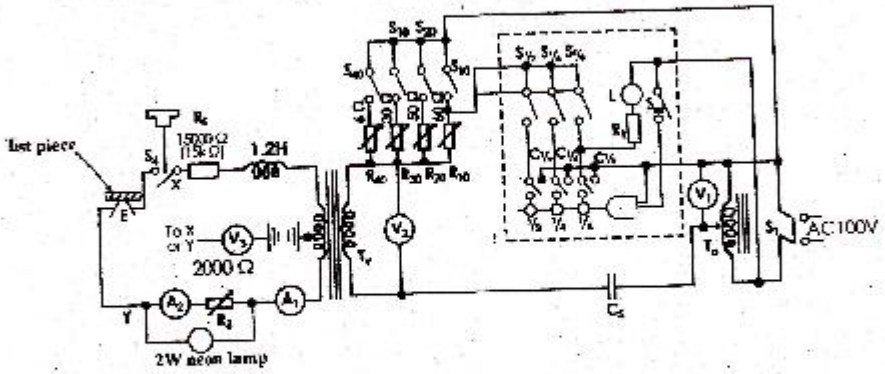
Similar measurements are made after keeping the test pieces for 14 days in boiling water.

8.17 MEASUREMENT OF ARC RESISTANCE

8.17.1 Apparatus :

Electric Circuit : An electric circuit shown in Figure below , capable of applying an open-circuit voltage of 12,500 V (12.5 kV) with a commercial frequency between the electrodes, in the sequence shown in Table below.

Circuit for Testing Arc-Resistance



A-ammeter V-Voltmeter M-Motor E-Electrode section C-Contactor

S-switch L-Pilot Lamp T_v- High –voltage transformer

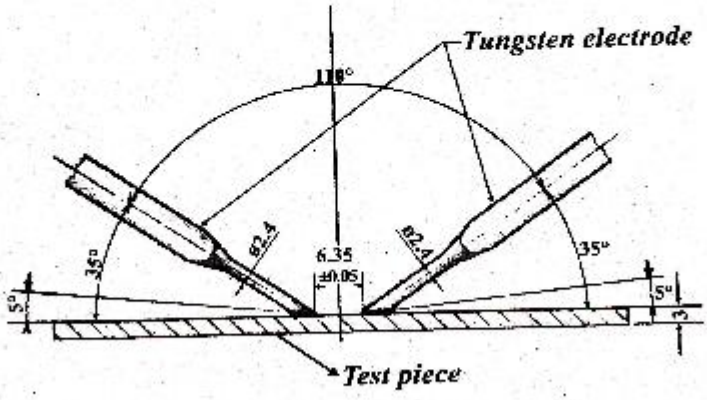
T_a- Variable-ratio autotransformer R-Resistor I – switching Device

Sequence of applying step voltages in testing for Arc-resistance

Current (mA)	Operation	Duration of on or off-time	Duration of each step (s)	Total duration (s)
-	Turn on S_1 Adjust T_a. Turn on S_m	-	-	-
10	Turn on S 1/8 as soon as pilot goes out. start stopwatch	Closed fpr 1/4 s. Open for 1 3/4 s	60	60
10	Turn on S 1/4	Closed for 1/ 4 s. Open for 3/4 s	60	120
10	Turn on S 1/2	Closed for 1/4 s. Open for 1/4 s	60	180
10	Turn on S10	Closed continuously	60	240
20	Turn on S20	Closed continuously	60	300
30	Turn on S30	Closed continuously	60	360
40	Turn on S40	Closed continuously	60	420

Electrode Assembly for Testing Arc-Resistance

Unit: mm



FIGURE

8.17.2 **Electrode** : Tungsten rods as shown in Figure above. Each with a length of 20 mm and a diameter of 2.4 mm, and with the tip ground to an inclination of 30 ± 1 degrees from its axis.

8.17.3 **Electrode Assembly** : An electrode assembly in which the tips of two electrodes are on the same plane, the axes of the electrodes are both inclined 35 degree from horizontal, the minor axes of the elliptic faces at the tips are horizontal, their tips are 6.35 ± 0.05mm apart from each other and the load on the test piece exerted by each electrode can be maintained at 50 ± 5 g.

8.17.4 **Stopwatch** : A stopwatch graduated in 0.2 s divisions.

8.17.5 **Micrometer Calliper** : The micrometer calliper for external measurement specified in JIS B 7502 or one with an accuracy at least equivalent.

8.17.6 **Test Piece**: Use a test piece moulded into a disc 100 mm in diameter and 3.0 ± 0.25 mm in thickness having smooth test surface.

8.17.7 **Curing Cycle**: Curing cycle at **150 deg. C for 5 hrs**.

8.17.8 **Conditioning** : Condition the test pieces under C - 90±4 h/20 ± 2° C/ 65 ± 5% RH.

8.17.9 **Procedure** : Measure the thickness of the test piece in the middle to the nearest 0.01 mm. Make certain whether or not the location of both electrodes on the test piece and the distance between them are correct.

Place the conditioned test piece horizontal, locate the arcing position on the test piece not less than 10 mm apart from the edge and from the parts which were previously subjected to the tests.

Shut out the draught, close the switch S, and adjust the variable-ratio auto-transformer T_a to give an open circuit voltage of 12.5 kV between the electrodes When the switch S_m is closed, the pilot lamp L flickers. Start the stopwatch as soon as the pilot lamp goes out, and simultaneously close the switch S 1/8. If the test piece is not broken by the arc in 1 min. successively close the switch S 1/4, and if it is not broken in 1 min, close the switches S1/2, S10, S20, S30 and S40 in 1 min steps, following the sequence of the current steps given in the table. At the instance when the test piece breaks and the arc goes out, stop the stopwatch and open the switch S1. Measure the time from the start of test to the going out of arc to the nearest 1 s. , and take it as the arc-resistance time (s). In this case, the test is carried out under the conditions of (20 ± 2 deg. C temperature, 65 ± 5% RH)

9. PACKING:

9.1 The tape shall be wound on a hard tubular plastic core with sufficient tension to form a compact roll but without deforming the construction of tape. The internal diameter of core shall be 83 ± 1 mm and its width shall approximately be the same as the width of tape.

9.2 The individual roll of the same thickness , width and length shall be individually packed in polyethylene to ensure that these can be easily separated and are protected from moisture, dust, direct sunlight and damage during transit.

9.3 The tape in the form of rolls of ordered width , thickness and length, should suitably be packed in polyethylene bags individually which should not be tampered until time of use and kept in a heat resistant thermocol boxes having wall thickness of minimum 25 mm and having dry ice (Frozen carbon-di-oxide gas) inside the thermocol boxes. The boxes shall be suitable to maintain the temperature between 15 °C to 25 °C. Thermocol boxes should be kept in a suitable carton so that it may not get damaged during transportation. After the tape is received , it should immediately be transferred to the consignee's cold storage. (not cooled by air-conditioners) which should run and maintain specified temperature continuously 24 hours without stopping after office hours and holidays & a log book should be maintained to monitor the temperature of cold storage.

10. STORAGE

10.1 Storage life(Shelf life) : The storage life depends upon storage temperature. For prolonged life, the tapes are stored in original carton in cool dry cold storage

preferably refrigerated cold storage. Optimisation of chemical composition of synthetic resin and process must ensure that the material shall retain the properties prescribed in the standard during storage at different temperatures for period not less than given in Table below after the date of manufacturing which normally shall not be earlier than 15 days from the date of readiness date given in inspection call letter/inspection.

S.No.	Storage Temperature °C	Shelf life months
1	10	18
2	15	12
3	20	8

10.2 Storage in sheds The tapes should be stored in original carton without tampering polyethylene bags in cool dry storage area. The tape roll should be taken out from refrigerator/cold storage 24 hrs. in advance before application, so that the tape can be brought fully to ambient temperature (Room temperature). On account of this, the condensed water on the polyethylene bag will not come in contact with the tape and the tape will be saved. If it comes in contact with water, the water will damage the sensitive chemicals of the resin inside tape rolls.

11. MARKING

11.1 Each roll of tape shall be legibly marked with the following information:

a) Manufacturer's /Supplier's name
b) Type of tape/Designation/trade-mark, if any
c) Length of roll, in metres
d) Thickness and width of tapes, in mm
e) Date (Month & Year) of manufacture (shall not be earlier than 15 days prior to the date of despatch) & (Month & Year) of expiry
f) Batch/Lot No.

11.2 Each transit pack (carton), containing number of rolls as agreed to between the consignee and the supplier shall have the following information, clearly and indelibly marked on it:

- RDSO specification no. E-7/17 Rev "1" of May 2004
- Railway's purchaser order no.
- Manufacturer's/supplier's name
- Type of tape/Designation/trade-mark, if any
- Batch/Lot No.
- Length of roll, in metres
- Thickness and width of tapes, in mm
- No. of Rolls & meters supplied
- Date (Month & Year) of manufacture and shelf life expiry date under specified storage condition
- Condition of preservation