SN-98

INDIAN RAILWAYS

सत्यमेव जयते

RDSO SPECIFICATION
No. M&C/ PCN/ 100/ 2024

SPECIFICATION FOR HEAT REFLECTIVE & THERMAL BARRIER PAINTING SYSTEM (TWO PACK) FOR THE EXTERIOR PAINTING OF RAILWAY COACHES, DIESEL AND ELECTRIC LOCOMOTIVES AND OTHER INDUSRIAL APPLICATIONS.

PAINTING SYSTEM

Epoxy Zinc Phosphate Primer
Epoxy Based Putty
Thermal Barrier High Build Epoxy
Heat Reflective &Thermal Barrier Full Gloss PU Enamel (2 coats)

S N	Month/Year of Issue	Revision/ Amendment	Reason for Revision/ Amendment
1	1986	NIL	First Issue
2	1996	Rev-01	Instruction for use shifted to Chapter-I
3	2005	Rev -01(Amdt)	Reaffirmed
4	July,2006	Rev-01(Amdt)	Mixing ratio well defined for all components
5	May,2009	Rev -01(Amdt)	(i)Test method & limits for % Unreacted Monomer & Poly Iso Cyanate. (ii)Humidity test, Abrasion & water resistance test etc included.
6	August,2013	Rev-01(Amdt)	Reaffirmed
7	January, 2018	Rev -02	Supply Apply contract and Revenue contract introduced

ISSUED BY M&C DIRECTORATE
RESEARCH DESIGNS &STANDARDS ORGANISATION
LUCKNOW-226 011

Signature	Prepared By	Checked By	Approved By
Name & Designation	18.12.24 ASI/R	DD/M&C-VI 18.12.24	

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SPECIFICATION FOR HEAT REFLECTIVE &THERMAL BARRIER PAINTING SYSTEM (TWO PACK) FOR THE EXTERIOR PAINTING OF RAILWAY COACHES, DIESEL AND ELECTRIC LOCOMOTIVES AND OTHER INDUSTRIAL APPLICATIONS

FOREWORD:

This standard for Epoxy cum Polyurethane painting system intended to be used for exterior painting of railway coaches, diesel, electric locomotives and other industrial applications probably the best available painting system for corrosion protection of steel was first prepared by Metallurgical & Chemical Directorate of RDSO and first issue was published in 1986. Polyurethane coating systems are extremely durable providing colour stability & exterior gloss retention to maintain aesthetics and **pleasant** look of IR coaches for an extended period. It not only wards off corrosion but also fortifies the coaches against chemical attack and **mechanical** damage. Subsequently, this specification was revised time to time according to the needs of Indian Railways. In order to address the issue of temperature of roof top of coaches and to bring down the roof top temperature and temperature inside coaches during summer season, IS: 17218:2019, Solar Thermo-reflective Exterior Coating for coating of Roof Top was issued by BIS. Now, GM/CLW suggested that IR should use heat insulating paint so that temperature inside coaches goes down by say 5 °C with significant energy savings in AC coaches. This will improve the comfort level of the passengers for coaches, reliability of electronic components in loco cabin will go up with reduction of temperature inside and Driver will also feel more comfortable. Considering the above valuable suggestion, revision of existing painting system for exterior painting of sidewall & end wall of coaches & loco cabins is taken up by incorporating thermally reflective material/heat insulating ingredients **with test parameters**, so that application of this material may be useful on the exterior surface of IR coaches to reduce the inside temperature by at least 5 °C.

1. INTRODUCTION:

Indian Railways have adopted heat reflective & thermal barrier painting system for exterior painting of railway coaches, diesel , electric locomotives etc. This specification consists of technical and Physico-chemical requirements of heat reflective & thermal barrier paint system.

2. STRUCTURE:

This specification has been divided into 05 chapters designated as under:

i) General : Chapter-I
ii) Epoxy Zinc Phosphate Primer : Chapter–II
iii) Epoxy Based Putty : Chapter-III
iv) Thermal Barrier High Build Epoxy : Chapter-IV
v) **Heat Reflective &Thermal Barrier** Full Gloss PU Enamel (Two Pack) : Chapter-V

NOTE: **"Firm should comply Make in India Policy and Public Procurement (Preference to Make in India) Order-2017 under this specification" and subsequent Amendment done time to time.**

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CHAPTER-I

1. **GENERAL:** This Chapter provides information with regard to Surface preparation, details of various components of painting system, aspects to be adhered to by the manufacturers, procurement details to be followed by the users and other important aspects.

2. **Surface Preparation:** The substrate shall be degreased by using suitable Petroleum Hydrocarbon solvents to IS: 1745-2018 or latest version. After degreasing, the surface shall be prepared by **shot**/grit/garnet blasting to white metal and the prepared surface shall match to minimum A Sa 2.5 of ISO Specn No. 8501-1(2007 or latest).

3. **Components of the Painting system**: The painting system has the following Components:-

Sl. No.	Painting operation	Description of paint	Method of Application	Chapter of Specification No. M&C/PCN/ 100/2024
1	Priming	Epoxy Zinc Phosphate primer	Airless spray	Chapter-II
2	Putty	**Epoxy Based Putty**	By Knife/ Spatula	Chapter-III
3	Intermediate coat	**Thermal Barrier High Build Epoxy**	Airless Spray	Chapter-IV
4	Finishing	Heat Reflective &Thermal Barrier Full Gloss PU enamel	-do-	Chapter-V

4. **Important Instructions:**

A. For manufacturers:

i. The paint Manufacturers shall indicate the presence of un-reacted monomer in the system to ensure freedom from pollution hazards **(See Annexure-XIII).**

ii. For touch up painting, during POH, the paint supplier shall supply the material in one liter packing. However, bulk supply of paint shall be in 20 liters packing. Unless otherwise agreed to between the purchaser and the supplier, the material shall be packed in metal containers conforming to IS: 1407 and IS: 2552.The packing is subject to the provisions of the law in force in the country at that time.

iii. **Epoxy putty** shall be supplied in small containers and after mixing the contents of both the packs, the amount of putty should be 5 ± 0.5 Kg which can be easily consumed within its pot life i.e. 30 minutes.

iv. Each component as delivered shall be free of gel, coarse particles, skins, foreign matter and sediments. Any sediment formed in the container shall be mixed thoroughly, preferably with power driven stirrer to form homogeneous paint.

v. Manufacturers shall submit internal test certificate for each product for all the parameters specified, at the time of supplying the material.

vi. Manufacturers shall submit material safety data sheet (MSDS) along with the supplies.

vii. *Manufacturer shall certify that the paint material is free from health hazardous material like Cr, Pb, Hg, Asbestos etc.* and also that the material is free from carcinogenic and Estrogen minimic solvents.

viii. For touch up/patch painting, the material shall be supplied **preferably** in one liter container.

ix. All paints including thinner for the above painting systems must be procured from the same source to ensure compatibility.

x. Normally, the items should not be procured as individually as the performance of top coat based on the compatibility of the other items/**components**, such as primer, putty & surfacer. However, in case of unavoidable circumstances, procuring individually up to 1500 ltrs can be accepted by acceptance test.

xi. **Application**:

The material after mixing both the components shall be compatible with the paint applications techniques such as brushing, spraying including air spraying and airless spraying.

xii. **Marking and Packing**: Each container shall be marked with the following:-

a. Name of the material and indication whether primer, putty, undercoating or finishing.
b. Indication of the source of manufacture.
c. Lead Content (Maximum).
d. Volume of the material.
e. Batch No. or Lot No. in code or otherwise.
f. Mixing **ratio**/proportion recommended for use.
g. Month & year of manufacture.
h. Shelf life of paint /material in container and temperature to be stored at.
i. The mixture of base and hardener shall be allowed to mature for 20 minutes at (27 ± 2) °C. The mixture must be consumed within 4 h after mixing or as per the pot life recommended by the manufacturer.
j. Other instructions for safe handling and use of the material; and
k. A cautionary note as below (**See Annexure-XIII**) also for health hazards and safety measures:-
    1) Keep out of reach of children.
    2) Dried film of this paint may be harmful if eaten or chewed.
    3) This product may be harmful if swallowed or inhaled.

l. **Lead Restriction:**

The material shall not contain lead or compounds of lead or mixtures of both, as metallic lead more than 90 ppm, when tested for restriction from lead in accordance with ICP-OES or AAS method of IS 101 (Part 8/Sec 5).

m. **Volatile Organic Compound(VOC limit):**

Volatile Organic Compounds (VOC) — any organic compound having an initial boiling point less than or equal to 250 °C measured at a Standard atmospheric pressure of 101.3 kPa.

NOTES:

1 It is in-can VOC as supplied by manufacturer, without including any thinner. Since the amount of thinner used on-site can vary depending on the application method (brushing, spraying, etc.), it can be challenging to precisely track the extent of thinning during application.

2 VOCs of colorant added at Point of Sale. The VOC content of product including the colorant added at the point-of-sale shall not exceed **the range** (250-450) grams per litre over and above the allowed VOC limit of product without colorant.

3 For the calculation of the VOC content, either Method 2 or Method 3 may be employed as given in the IS 101 (Part 2/Sec 3) and IS 101 (Part 2/Sec 4) respectively.

B. For bulk supply, frequency of full testing of the material as per **D (v) Table-II & (vi)** may be decided by the purchaser. Purchaser reserves the right to conduct tests for any parameter at any time.

C. Procurement Authorities :

(i) **Paint procured through Indian Railway store contract.**

Indian Railways are using cleaning compositions for cleaning of exterior of coaches to RDSO Specification No. M&C/ PCN / 101/ 2020, taking into this and other aspects such as prevailing operating / service conditions, the Manufacturers will take warranty of their material regarding gloss retention shall not be less than 60 units at 60° angle of incidence , colour retention for a period of three (03) years and adherence property at the time of supplying the painting system under Supply-Apply contract , to be used for painting of railway assets. Mechanical damage and any other painting defect arises during service shall be repaired by the contractor on their own cost. Other cleaning /washing/polishing agent shall be of contractor choice and on their own expenses during the warrantee period. The minimum acceptable limits, for the above properties, after various duration are as follows (Table-I):

Table-I

S.No.	Time Period	Gloss Retention (Initial gloss>85 units at 60° angle of incidence)	Colour Retention Rating on 0-10 scale (Initial rating of painted panels/ coach or ISC/RAL Shade Card shall be taken as 10)	Adherence of Paints (with each other and with substrate) Cross-Cut Tape Adhesion test as per ASTM D:3359/97 (or latest)
1.	After 1 Year	80% of initial gloss	7	5B
2.	After 2 Year	70% of initial gloss	6	5B
3.	After 3	60% of initial	5	4B

	Year	gloss		

(ii) Paint procured through Supply-Apply and Maintenance contract:

The paint procured by Indian Railway through Supply–Apply and Maintenance contract, the contractor shall take responsibility of mechanical/paint film damages due to peel off, flaking off, cracking, chalking and delamination i.e. all types of adhesion related premature failure for the entire Warrantee Period of 03 years during service from the date of application under maintenance contract as per laid down terms & conditions of P.O. The defect arises during Warranty period shall be repaired by the contractor on their own cost. However, Production units (PU), Zonal Railway workshops and other consignee shall frame their own terms and conditions of Supply-Apply and Maintenance contract for procurement of this paint and the same shall be introduced in P.O.

D. Testing Authorities :

i) **Representative samples of the material shall be drawn as per IS 101 – 86 (Part 1/Sec 1), Reaffirmed-2017 or latest.**

ii) The paint shall be tested after mixing pack A & B in the stipulated ratio as mentioned in corresponding chapter of different components of paint system. No thinner shall be employed until recommended by the manufacturer.

iii) The two-component paint shall be mixed in the ratio recommended by the manufacturer of the paint before conducting the test or tests. During mixing of two components in large quantities, the mixing may be done using a high-speed stirrer and the rise in temperature shall not be more than 5 °C

iv) Quality of Reagents: Unless specified otherwise, pure chemicals and distilled water shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

v) The following tests in this specification are defined as Type tests-

TABLE-II

SN	Name of the paint component	Type Tests
1.	Epoxy Zinc phosphate primer (Two packs)	(a) Resistance to Salt Spray (b) Protection against corrosion under condition of condensation
2.	Heat reflective &Thermal barrier Full Gloss PU enamel	(a) Accelerated weathering test (b) Humidity Test (c) Resistance to tap water

vi) All other tests as laid down in the specification are defined as Acceptance Tests

vii) At the time of initial approval all characteristics of paints after mixing pack A and B in the stipulated ratio as mentioned in corresponding chapter of different components of paint system shall be tested as per the specification.

viii) When the total quantity of the paint purchased is up to 10 below-coach sets in single or multiple lots, the acceptance or rejection by the inspecting agency shall be of each multiple lot or the entire single lot based on test results of the acceptance tests.

ix) When the total quantity of paint to be purchased is more than 10 coach sets, testing of each multiple lot (part quantity) shall be carried out for acceptance test and/or type tests as given below-

Lot quantity	Tests to be conducted
1st lot up to 50 coach sets of each lot	Acceptance Tests and Type Tests
2nd , 3rd & 4th lots up to 50 coach sets of each lot	Acceptance Tests
5th lot up to 50 coach sets each lot	Acceptance Tests and Type Tests
6th ,7th& 8th lots up to 50 coach sets of each lot	Acceptance Tests
9th lot up to 50 coach sets of each lot	Acceptance Tests and Type Tests
10th ,11th& 12th lots up to 50 coach sets of each lot	Acceptance Tests

E. Coach Builders :

i) Normally addition of thinner in prepared paint (obtained after mixing Pack A & Pack B in recommended mixing ratio) shall not be required. If environmental fluctuations (e.g. fall in temperature) take place, then small amount of thinner as recommended by the manufacturer, subject to a maximum of 10% (v/v), may be added to adjust the spray viscosity.

ii) For ensuring adherence to flash off time, after the painting operation, the coach shall be placed at the entrance of the curing oven and the coach shall be moved inside the oven slowly to cover the stipulated flash off time.

iii) **Epoxy putty** may be prepared by mixing the contents of both the packs near the coach in small batches, as per the requirements, which can be consumed with in its pot life i.e. 30 minutes.

CHAPTER-II

SPECIFICATION FOR EPOXY BASED ZINC PHOSPHATE PRIMER (TWO PACK)

1. SCOPE

1.1 This standard specifies requirements and methods of testing of Epoxy based Zinc Phosphate Priming paint supplied in two packs, intended to be used, for coaches, bridges and special type of wagons. Two components epoxy zinc phosphate primer is intended to be used as an anti-corrosive primer over garnet/ grit/**shot** blasted surface to A Sa2½ of ISO: 8501-I(2007 or latest).The material shall have good adhesion on the substrate and shall have good compatibility with subsequent coats of two pack epoxy based putty, two pack thermal barrier high build epoxy and two pack polyurethane based top coat paint (Heat Reflective &Thermal Barrier), as the painting system may require the application of these materials. The primer should be suitable for spray application (as per Chapter I, Para 3) It may also be suitable for application by brush for touching up smaller areas.

1.2 The paint obtained by mixing the material in two packs is used as a highly protective anti-corrosive primer on steel surfaces for providing a much higher degree of protection than conventional single pack primers.

2. TERMINOLOGY

2.1 For the purpose of this standard apart from the glossary of terms given in IS: 1303-2022 or latest version and Cl.2 of IS: 9162-79, (Reaffirmed-2016) or latest version, the following shall also apply. Rounding off, of observed values on different tests shall be in accordance with IS: 2-2022 or latest version.

2.1.1 **Pack:**
The term used to describe each of the two packs of the paint which when mixed together, form an epoxy based zinc phosphate priming paint.

2.1.2 **Paint:**
The mixture of the 2 packs, along with thinner, in the proportion recommended by the manufacturer. The mixing of the two packs shall be done with the heavy duty stirrer for 15 minutes max (the rise in temp. shall not be more than 5°C).

3. REQUIREMENTS:

3.1 The mixing ratio of the pack A and pack B shall be simple ratio and same as supplied in dual containers.

3.2 **Composition:**
The paint shall consist essentially of two packs, namely pack A and pack B

3.2.1 **Pack A**: (Normally referred to as base) shall consist of (a) Epoxy resin
(b) Pigment.

3.2.1.1 In the formulation of the paint, epoxy resin of the following grade shall be used:-

TABLE I: REQUIREMENTS FOR EPOXY RESIN

S. No.	Characteristics	Requirement	Method of test
1.	Weight per epoxy equivalent on non-volatile vehicle content basis, g/mole	(400-500)	CL. 4 of IS:9162-79 (Reaffirmed-2016) or latest version

3.2.1.2 Pigment Content:

The paint shall contain (45 ± 5) % by mass of pigment on the mass of paint and a minimum of 16% by mass of zinc phosphate pigment, on the basis of, % by mass of total pigment apart from other pigment, such as extenders, as may be necessary conforming to IS : 10897-84, (Reaffirmed-2002) or latest version when both the components mixed in the ratio as given by manufacturer tested as per of Part 8/ Section 2 of IS: 101-90, (Reaffirmed-2017) *or* latest version by using the following extraction mixture:-

i) Methyl iso-butyl ketone or Methyl ethyl ketone or Mixture of both 1:1 by volume in the ratio — 25%byvolume
ii) Xylene — 50 % by volume
iii) Acetone — 25 % by volume

3.2.1.3 The pigment shall conform to IS: 10897-84 (Reaffirmed-2002) or latest version (Specification for zinc phosphate pigment).

3.2.2 **Pack B:** (Normally referred to as Hardener or catalyst solution)
This shall be liquid type, such as an aliphatic amine, an aliphatic or aromatic amine adducts, a polyamide or amido polyamine or any other suitable hardeners. *It shall react with epoxy resin at normal ambient temperature.*

4. **Properties:**

4.1 **General:** The paint shall comply with the requirements specified in Table II of this specification.

4.2 Unless otherwise specified, the following testing conditions shall apply.

4.2.1 *The preparation of M.S. panel as per IS: 513-2016 or latest version shall be in* accordance with Cl.5.2.1.1 of IS: 101-86 (Reaffirmed-2017) or latest version.

4.2.2 All the tests shall be conducted at room temperature (27 ± 2)° C and a relative humidity at (65 ± 5) % in a well-ventilated chamber free from draughts and dust.

4.2.3 **Condition in Containers**: Each component as delivered shall be free of gel, coarse particles, skins, foreign matter and sediments. Any sediment that does form must be easy to stir up with a high speed stirrer for 15 minutes maximum, in order to give a homogenous paint.

4.2.4 The two packs i.e. base and hardener shall be mixed in the ratio as recommended by the manufacturer, before conducting the test or tests. Where the paint is required to be applied on panels, it shall be done so by suitable spray (as per Chapter I, Para 3). After mixing the two components thoroughly, an induction time of 15 to 20 minutes shall be allowed before use.

TABLE II - REQUIREMENTS FOR EPOXY BASED ZINC PHOSPHATE PRIMER (TWO PACK)

Sr. No.	Characteristics	Requirements	Test Method
1.	Drying time a) Surface Dry, max b) Hard Dry, max c) Hard Dry at 70°C, max	 3 hours 8 hours 30 minutes, with 15 minutes flash off time	IS : 101-86 (Part 3/ Sec. 1), (Reaffirmed 2017) or latest version
2.	Consistency	Smooth and uniform, suitable for brush/spray application	IS : 101-89 (Part 1/ Sec.5), (Reaffirmed 2019) or latest version
3.	Finish	Smooth and matt to egg shell flat	IS : 101-87 (Part 3/ Sec. 4),(Reaffirmed 2019) or latest version
4.	Colour	Red Oxide or Grey or close match to the specific IS as in IS 5/RAL colour or to an agreed colour where IS/RAL colour is not specified	IS: 101-89 (Part 4/ Sec. 2), (Reaffirmed 2019) or latest version
5.	Dry film thickness, per coat	(60-80) microns	IS: 101-89 (Part 3/ Sec.2), (Reaffirmed 2019) or latest version or By Elcometer
6.	Volume Solids, %, Min	50.0	APPENDIX-1
7.	Scratch Hardness (1.5 Kg LOAD)	No such scratch so as to show base metal	IS: 101-88 (Part 5/ Sec. 2), (Reaffirmed 2019) or latest version
8.	Flexibility & Adhesion (6.25 mm mandrel)	No visible damage or detachment of film	IS: 101-88 (Part 5/ Sec. 2), (Reaffirmed 2019) or latest version
9.	Flash Point (a) Component A (b) Component B	 Above 20°C Above 20°C	IS: 101-87 (Part 1/ Sec.6), (Reaffirmed 2019) or latest version
10.	Resistance to salt spray	No sign of corrosion & no sign of deterioration viz. blistering, detachment of film up to 500 Hrs.	ASTM B – 117/90
11.	Protection against corrosion under condition of condensation	-do-	IS: 101-88 (Part 6 /Sec.1), (Reaffirmed 2020) or latest version
12.	Keeping Properties for both the packs	Min. 12 months	APPENDIX-III
13.	Mass in Kg/10 litres,	12.5-14.5	IS : 101-87 (Part 1/ Sec.7), (Reaffirmed 2019) or latest version
14.	Pot life (After induction time) min., at i) (27 ± 2)°C ii) (40 ± 2)°C	 3 hours 30 minutes 2 hours	APPENDIX-II

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15.	Theoretical Spreading Capacity, min	8 Sq.m/ lt., at 60 microns DFT	APPENDIX-I
16.	Fineness of grind	(20-30) microns	IS : 101-87 (Part 3/Sec 5), (Reaffirmed 2019) or latest version
17.	Viscosity (Efflux time by Ford cup No. 4of paint i.e. mixture of two components at (27±2)°C in Supply condition.	70 sec, Max .	IS : 101-89 (Part 1/Sec5), (Reaffirmed 2019) or latest version

TABLE-III:DETAILS OF PREPARING PAINTED PANELS FOR TESTING EPOXY BASED ZINC PHOSPHATE PRIMER (TWO PACK):

Sl. No.	Test	Type of Metal Panel	Size in mm. (Ref: IS 101 (Part 1/Sec 3)	Painting Detail	DFT	Method of applicati on	Duration of Air Drying Before Commencem ent of test (Applicable for panels either air dried or dried at elevated temperature)	Special Instructions
1.	Drying time	M.S.as per IS:513-2016 or latest	150 X 100 X1.25	One coat of epoxy Zinc Phosphate Primer	(60-80) microns	as per Chapter I, Para 3	-	-
2.	Finish	-do-	-do-	-do-	-do-	-do-	48 hours	-
3.	Colour	-do-	-do-	-do-	-do-	-do-	24 hours	-
4.	Dry film thickness	-do-	-do-	-do-	-	-do-	-do-	- -
5.	Flexibility & Adhesion	Tinned	150 mm X 50mm X 0.315mm	-do-	-do-	-do-	7 days	-
6.	Scratch Hardness	-do-	-do-	-do-	-do-	-do-	-do-	Apply a load 1.5 Kgs as per Cl. 15.1 .2 of IS: 101-88(Pt 5/Sec 1) (Reaffirmed-2019) or latest version
7.	Resistance to Salt Spray	M.S.	150 mm X 100 mm X 1.25mm	-do-	-do-	-do-	-do-	For 500 hours
8.	Protection against corrosion under conditions of condensation	-do-	-do-	-do-	-do-	-do-	-do-	-do-

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CHAPTER –III
SPECIFICATION FOR EPOXY BASED PUTTY (TWO PACK)

1. SCOPE

This standard specifies requirements and methods of testing a two-pack epoxy based putty intended to be used for leveling up the surface imperfections of the exteriors of Railway Coaches, Diesel and Electric Locomotives and other industrial applications. It is suitable for application by knife of about 30 cm width or more.

1.1 USES:

Material complying with this standard is intended to be used for levelling up effectively the surface imperfections viz., dents and depressions less than 2 mm of the exterior of Railway Coaches, Diesel and Electric Locomotives and other industrial applications. Dents more than 2 mm may be filled in, with the help of fillers based on **epoxy resin** filled with glass bubbles or any other suitable material. The material shall have good compatibility with Epoxy Zinc Phosphate primer on which it is to be applied and with **thermal barrier high build epoxy**, which is to be used as a subsequent coat.

1.2 DEFINITION:

For the purpose of this standard, the glossary of terms given in IS: 1303-2022 or latest version, shall apply. Rounding off, of observed values on different tests shall be in accordance with IS: 2-2022 or latest version.

2. MATERIAL REQUIREMENTS AND PROPERTIES:

2.1 COMPOSITION

The Epoxy Based Putty shall consist essentially of two components, namely COMPONENT 'A' & COMPONENT 'B'.

COMPONENT 'A' (normally referred to as base) shall consist of:

(i) An appropriate epoxy resin,
(ii) Appropriate pigments, extenders, solvents and additives.

In the formulation of the putty, epoxy resin of the following grade shall be used:-

REQUIREMENTS FOR EPOXY RESIN

S. No.	Characteristics	Requirement	Method of test
1.	Weight per epoxy equivalent on non-volatile vehicle content basis, g/mole	(200-500)	CL. 4 of IS:9162-79 (Reaffirmed-2016) or latest version

COMPONENT 'B': (Normally referred to as Hardener) shall consist of any liquid hardener.

Liquid Hardener: This shall be liquid type such as an aliphatic amine, an aliphatic or aromatic amine adduct, a polyamide or amido polyamine or any other suitable hardener. It shall react with epoxy resin at normal ambient temperature.

The material shall be of such a composition as to satisfy the requirements of this standard. In order to obtain satisfactory rubbing properties, use of slate powder along with suitable extenders and pigments, as may be necessary, is recommended.

MIXING RATIO: The mixing ratio shall be according to the recommendation of the supplier.

1.1 PROPERTIES:

2.2.1 GENERAL:

The paint shall comply with the requirements specified in TABLE-1 of the specification.
Unless otherwise specified, the following testing conditions shall apply:

The preparation of metal panels shall be in accordance with Clause 5.2 to 5.2.1.2 of IS: 101-1986, (Reaffirmed 2017) or latest version.

All tests shall be conducted at room temperature $(27 \pm 2)^0$ C and a relative humidity of (65 ± 5) % in a well-ventilated chamber free from draughts and dust.

The two-component Epoxy Based Putty (Component 'A' & 'B') shall be mixed in the ratio recommended by the manufacturer (before conducting the test).

2.1.1 PREPARATION OF PANELS FOR TESTING:

For the preparation of painted panels for conducting different tests mentioned in Table-I, the details given in Table-II shall be followed.

2.1.2 CONDITION IN CONTAINER:

Each component, as delivered, shall be free of gel, coarse particles, skins, foreign matter and sediments. Any sediment, that does form, must be easy to stir up with a high speed stirrer for 15 minutes maximum, in order to give a homogeneous paste.

TABLE-I: REQUIREMENTS FOR EPOXY BASED PUTTY (TWO PACK):

Sl. No.	Characteristics	Requirements	Test Method
1.	Drying time a) Surface dry, max. b) Hard dry, max. c) Hard dry time at 70^{0}C, max.	 2 hours 8 hours 2 hours, with 30 minutes flash off time	IS : 101-86 (Part 3/Sec.1), (Reaffirmed 2017) or latest version
2.	Consistency	Smooth and uniform and suitable for knife application	IS : 101-87 (Part 1/Sec.5), (Reaffirmed 2019) or latest version
3.	Stopping properties	Shall show no sagging, cracking or shrinkage	APPENDIX-VIII
4.	Rubbing properties	Shall dry rub with 150grade paper and wet rub with 280 grade water proof paper without clogging of the paper and shall not show defects like roughness, scratches, cracks and pinholes after rubbing.	APPENDIX-IX
5.	Hold out Property	Finish with uniform gloss and colour	APPENDIX-X
6.	Adhesion & Compatibility of Paint System	Good adhesion and compatibility of the paint system	Appendix-XI and ASTM D 3359-09 or latest version
7.	Pot life (After induction time) min., at i) (27 ± 2)°C ii) (40 ± 2)°C	 3 hours 30 minutes 3 hours	See note
8	% Solids, , min	85	IS: 101-87 (Part 8/ Sec 2), (Reaffirmed 2017) or latest version
9.	Keeping properties	Not less than twelve months	APPENDIX-III

Note: Pot life is taken as the duration up to which the mixed material is still in a usable condition, starting from the time of mixing.

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TABLE –II: DETAILS OF PREPARING PAINTED PANELS FOR EPOXY PUTTY (TWO-PACK)

Sl. No.	Test	Type of metal panel	Size in mm (Ref: IS 101 (Part 1/Sec 3)	Painting detail	D.F.T., minimum	Method of application	Duration of Air Drying before commencement of test (Applicable for panels either air dried or dried at elevated temperature)
1.	Drying time	M.S.as per IS:513 -2016 /or latest	150X150 X1.25	One coat of epoxy putty	300 microns	By knife/ spatula	-
2.	Stopping properties	-do-	300X150 X0.9	One coat of zinc phosphate primer (allow it to air dry for 8 hrs.) followed by three coats of epoxy based putty (giving interval of not less than 8hrs. and not more than 24 hrs. between successive applications)	(60-80) microns Total DFT 1000 microns;	By suitable Spray technique By knife/ spatula	- 02 Hours after application of each coat.
3.	Rubbing properties	-do-	-do-	One Coat of zinc phosphate primer (allow it to air dry for8 hrs.) followed by one coat of epoxy based putty.	(60-80) microns 300 microns	By suitable Spray technique By knife/ spatula	- 08 Hrs. after application of putty.
4.	Hold out property	-do-	300X150X0.9	One coat of zinc phosphate primer (allow it to air dry for 8 hrs.), followed by three coats of epoxy based putty (giving interval of not less than 8hrs. and not more than24 hrs. between successive applications) Allow final coat of putty to air dry for 08 hrs., followed by One coat of Thermal Barrier high build epoxy (allow it to air dry for 08 hrs.) followed by Two coats of Heat Reflective & Thermal Barrier PU full Gloss Enamel(apply 2nd coat after 8hrs of air drying of 1st coat)	(60-80) microns Total DFT 1000 microns 100 microns 35 + 35=70 microns	By suitable Spray technique Knife/ Spatula By suitable Spray technique -do-	- - - 48 hours
5.	Adhesion and compatibility in Paint System	-do-	300x150 x0.9	-do- (same as at S.No.4)	-do- (same as at S.No.4)	-do- (same as at S.No.4)	07days

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CHAPTER-IV

THERMAL BARRIER HIGH BUILD EPOXY (TWO PACK)

1.1 SCOPE

Material is intended to be used as a **thermal barrier high build epoxy** over a primed/putty applied surface for protection of exterior of passenger coaches, Diesel and Electric Locomotives and other industrial applications. The material is used with the object of getting a smooth, uniform and non-absorbent thermal barrier base for heat reflective & thermal barrier top coat paint. The material shall have good compatibility with two pack heat reflective & thermal barrier PU top coat paint and underneath Epoxy Based Putty.

1.2 DEFINITION:

For the purpose of this standard, the glossary of terms given in IS: 1303-2022 or latest version, shall apply.

1.3 COMPONENT:

The term used to describe each of the two parts of the paint which, when mixed together, form a pigmented polyurethane paint.

1.4 PAINT :

The mixture of the two components in the proportion recommended by the manufacturer

1.5 COMPOSITION:

The paint shall consist essentially of two components namely COMPONENT 'A' and COMPONENT 'B'.

COMPONENT 'A': (Normally referred to as Base) shall consist of epoxy resin with or without diluents.)

In the formulation of paint, (i) epoxy resin of the following grade shall be used.

Table – I Requirements for epoxy resin

S. No.	Characteristics	Requirements	Method of test
1.	Weight per epoxy equivalent on non-volatile content basis	(150-300)	Cl.4 of IS:9162-79

(ii) Appropriate heat reflective/insulating pigments heat reflective/insulating fillers, solvents and appropriate additives such as fiberglass, mineral wool, cellulose etc.

COMPONENT 'B': (Normally referred to as Hardener) shall consist of any liquid hardener.

Liquid Hardener: This shall be liquid type such as an aliphatic amine, an aliphatic or aromatic amine adduct, a polyamide or amido polyamine or any other suitable hardener. It shall react with epoxy resin at normal ambient temperature.

1.6 The two components **thermal barrier high build epoxy** (Component 'A' & 'B'), shall be mixed in the ratio recommended by the manufacturer of the paint before conducting the test or tests. Where the priming paint is required to be applied on panels, it shall be done so by using suitable spraying technique. After thorough mixing of the two components, an induction time of 15 to 20 minutes shall be allowed before use.

1.7 The airless spray gun shall be thoroughly cleaned before use. It shall be fitted with the correct size of nozzle and air cap, the pressure ratio of air cylinder to hydraulic cylinder shall be adjusted in accordance with the viscosity of the material to be sprayed. The material shall be sprayed carefully so as to obtain an even and uniform coat having a dry film thickness of (100-150) microns per coat. The mixed paint shall show good spraying properties on vertical panels. The film when dry shall be free from sags, runs, streaks and any other film defects.

1.8 **CONDITION IN CONTAINER:**
Each component, as delivered, shall be free of gel, coarse particles, skins, foreign matter and sediments. Any sediment that does form must be easy to stir up with a high speed stirrer for 15 minutes maximum in order to give a homogeneous paint.

TABLE-1

REQUIREMENT FOR THERMAL BARRIER HIGH BUILD EPOXY (TWO PACK)

Sl. No.	Characteristics	Requirements	Test Method
1.	Drying time a) Surface dry, max b) Hard dry, max c) Hard dry at 70^0 C max.	4 hrs. 8 hrs. 30 minutes, with 15 minutes flash off time	IS : 101-86 (Part 3/ Sec. 1), (Reaffirmed 2017) or latest version
2.	Consistency	Smooth and uniform, and suitable for spray application (as per Chapter I, Para 3)	IS : 101-89 (Part 1/ Sec. 5), (Reaffirmed 2019) or latest version
3.	Finish	Smooth and Matt to egg shell flat	IS : 101-87 (Part 3/ Sec. 4), (Reaffirmed 2019) or latest version
4.	Colour	White/Off-white or Close match to the specific IS **as in IS 5**/RAL colour or to an agreed colour where IS/RAL colour is not specified	IS : 101-89 (Part 4/ Sec. 2), (Reaffirmed 2019) or latest version
5.	Dry film thickness	(100-150) microns	By Elcometer
6.	Volume solids, %	(50-70)	APPENDIX-I

7.	Scratch hardness (1.5 Kg Load)	No such scratch so as to show base metal	IS : 101-88 (Part 5 /Sec 2),(Reaffirmed 2019) or latest version
8.	Flexibility & Adhesion (6.25 mm mandrel)	No visible damage or detachment of film	IS : 101-88 (Part 5 /Sec. 2), (Reaffirmed 2019) or latest version
9.	Flash point a) Component 'A' b) Component 'B'	 Above 20^0 C Above 20^0 C	IS : 101-87 (Part 1/ Sec. 6), (Reaffirmed 2019) or latest version
10.	Fineness of Grind	(20-30) microns	IS : 101-87 (Part 3 /Sec. 5), (Reaffirmed 2019) or latest version
11.	Pot life (After induction time), min i) (27± 2)^{0}C ii) (40± 2) ^{0}C	 3 ½ hours 2 hrs.	APPENDIX -II
12.	Mass in Kg/10 litres, min	12.0	IS : 101-87 (Part 1/ Sec. 7), (Reaffirmed 2019) or latest version
13.	Keeping properties	Min 12 months	APPENDIX-III
14.	Theoretical spreading rate, min	7.0 Sq. m./lt. at 100 microns DFT	APPENDIX-I
15.	Viscosity (Efflux time by Ford cup No. 4) of paint i.e. mix of two components at (27± 2)^0 C in Supply condition	(100-150) sec	IS : 101-89 (Part 1/ Sec. 5), (Reaffirmed 2019) or latest version
*16	Solar Reflectance Performance: (a)Solar Reflective Index-SRI (b)Emissivity Index (c)Total Solar Reflectance-TSR (d) Infra Red (IR) Rejection	a) i) 102.0,Min (for white) ii) 50 - 90 (for others except Black) (b) 0.92,Min (c) 0.89,Min (d) >90%	(a)ASTM E-1980/ (b) EN 673/ASTM C 1371 (c)ISO-9050/ASTM C 1549/ ASTM E 903 (d) ASTM G 173
*17	R Value (Thermal Resistance)	0.80 m ^{2}/K/W, Min	ASTM C 518
*18	Smoke & Fire Resistance	R7 (HL3)	EN-45545-2

***Note:** Test reports for Sr. No. 16 & 17 from MSME/NTH/CSIR/HBTU/Shri RAM Test House/NABL/NABCB accredited laboratory/any other Govt. Lab. for Fire & smoke resistance properties and solar reflectance performance properties shall be submitted during supply only.

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TABLE- 2
DETAILS OF PREPARING PAINTED PANELS FOR TESTING THERMAL BARRIER HIGH BUILD EPOXY (TWO PACK)

Sl. No	Test	Type of metal panel	Unless specified otherwise, Size in mm (Ref: IS 101 (Part 1/Sec 3)	Painting detail	D.F.T	Method of application	Duration of air drying before commencement of test (Applicable for panels either air dried or dried at elevated temperature)	Special instructions
1.	Drying time	M.S. as per IS :513 - 2016 or latest	150X100 X1.25	One coat of thermal barrier high build epoxy (Two Pack)	(100-150) microns	As per Chapter I, Para 3	-	-
2.	Finish	-do-	-do-	-do-	-do-	-do-	48 Hrs.	-
3.	Colour	-do-	-do-	-do-	-do-	-do-	24 Hrs.	-
4.	Dry film thickness	-do-	-do-	-do-	-do-	-do-	-do-	-
5.	Scratch hardness	Tinned	150X50 X0.315	-do-	-do-	-do-	7 days	Apply a load of 1.5 KgInstead of 1.0 Kg.
6.	Flexibility & Adhesion	-do-	-do-	-do-	-do-	-do-	-do-	-
7.	Solar Reflectance Performance: (a)Solar Reflective Index-SRI (b)Emissivity Index (c)Total Solar Reflectance-TSR (d) Infra-Red (IR)Rejection	M.S. as per IS:513 - 2016 or latest	(150 x 100 x 1.25) mm	-do-	(100-150) microns	-do-	-do-	(a)ASTM E-1980 (b) EN 673/ASTM C 1371 (c)ISO-9050/ASTM C 1549/ ASTM E 903 (d) ASTM G 173
8.	Smoke & Fire Resistance:	M.S. as per IS:513 - 2016 or latest	150 X150 X 1.25 mm	-do-	(100-150) microns	-do-	-do-	EN-45545-2

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CHAPTER – V

SPECIFICATION FOR HEAT REFLECTIVE &THERMAL BARRIER FULL GLOSS PU ENAMEL (TWO PACK)

1.1 **SCOPE:**

This standard specifies requirements and methods of testing a two-pack full gloss **heat reflective & thermal barrier** Enamel, intended to be used for the protection and decoration of exteriors of Railway Coaches, Diesel and Electric Locomotives and other industrial applications, against atmospheric corrosion **and passenger comfort on board against heat.** It is primarily suitable for application by spraying. It may also be applied by brush for touching up small areas.

1.2 **USES:**

Material complying with this standard is intended to be used as top coat in paint system for the protection of exteriors of Railway coaches, Diesel and Electric Locomotives and other industrial applications, against corrosion, involving wet and damp areas, high humidity, coastal/marine and industrial fallout. Heat reflective & thermal barrier paints are suitable for use in those exterior applications where it is desirable to retain colour and gloss for long periods of time in addition to providing excellent chemical, abrasion, corrosion resistance and act as a heat reflective & thermal barrier to reduce heat inside IR coaches, thus providing comfort to passengers on board.

1.3 **DEFINITION:**

For the purpose of this standard, the glossary of terms given in IS: 1303-2022 or latest version shall apply.

1.4 **COMPONENT:**

The term used to describe each of the two parts of the paint which, when mixed together, form a pigmented polyurethane paint.

2.1 **PAINT :**

The mixture of the two components in the proportion recommended by the manufacturer.

2.1.1 **COMPOSITION :**

The paint shall consist essentially of two components, namely **COMPONENT 'A'** and **COMPONENT 'B'**

COMPONENT 'A' (normally referred to as Enamel) shall consist of:

(i) An appropriate oil free Polyacrylate Polyol
(ii) Appropriate heat reflective/insulating pigments heat reflective/insulating fillers, solvents and appropriate additives

COMPONENT 'B' (normally referred to as HARDENER or catalyst solution) shall consist of:

(i) An aliphatic poly isocyanate
(ii) Appropriate solvents

To determine whether the poly isocyanate is aliphatic or aromatic in nature, carry out tests in accordance with the procedure in **Appendix- VII.**

2.1.3 MIXING RATIO:

The mixing ratio of the Component 'A' and Component 'B' shall be in ratio of 4:1 by volume or recommended by the supplier.

3.1 PROPERTIES:

3.2 GENERAL:

The paint shall comply with the requirements specified in TABLE-1 of the specification.

3.2.1 Unless otherwise specified, the following testing conditions shall apply:

3.2.2 The preparation of metal panels shall be in accordance with Clause 5.2 to 5.2.1.2 of IS: 101-1986 (Part1/Sec3), (Reaffirmed 2017)or latest version.

3.2.3 All tests shall be conducted at room temperature $(27\pm2)^0$ C and a relative humidity of (65 ± 5) % in a well-ventilated chamber free from draughts and dust.

3.2.4 The two components heat reflective & thermal barrier PU Finish Enamel (component 'A' & 'B'), along with thinner, shall be mixed in the 4:1 ratio or recommended by the supplier before conducting the test or tests. However, during mixing of the two components in large quantities for painting coach/locos, the mixing may be done by using a high speed stirrer for 5 minutes max. (Rise in temp. shall not be more than 5^0C). After through mixing of the two components, an induction time of 15 to 20 minutes shall be allowed before use. Where the enamel is required to be applied on panels, it shall be done so by using suitable spraying apparatus (as per Chapter I, Para 3).

3.2.5 The airless spray gun shall be thoroughly cleaned before use. It shall be fitted with the correct size of nozzle and air-cap, the pressure ratio of air cylinder to hydraulic cylinder **shall be adjusted in accordance with the viscosity of the material to be sprayed. The pressure ratio shall be adjusted in accordance with the viscosity of the material to be sprayed. The material shall be sprayed carefully so as to obtain an even and uniform coat having a dry film thickness of (35-45) microns per coat.** From the relationship (b) in Appendix-I, determine the approximate wet film thickness required to obtain the above specified dry film thickness.

3.2.6 The mixed paint shall show good spraying properties on vertical panels. The film, when dry, shall be free from sags, runs, streaks, and any other film defects.

3.2.7 The above condition holds good wherever the use of Epoxy Primer and **Thermal Barrier High Build Epoxy** has been recommended to be used along with the heat reflective &thermal barrier full gloss PU Enamel for testing.

4.1 PREPARATION OF PAINTED PANELS FOR TESTING:

4.1.1 For the preparation of painted panels for conducting different tests mentioned in Table-I the details given in Table–II shall be followed.

5.1 **CONDITION IN CONTAINER:**

5.1.1 Each component, as delivered, shall be free of gel, coarse particles, skins, foreign matter and sediments. Any sediment, that does form, must be easy to stir up with a high speed stirrer for 10 minutes maximum, in order to give a homogeneous paint.

TABLE I: REQUIREMENT FOR HEAT REFLECTIVE &THERMAL BARRIER FULL GLOSS PU ENAMEL (TWO PACK)

S. No.	Characteristics	Requirements	Test Method
1.	Identification of polyisocyanate	Aliphatic poly isocyanate	Appendix-VII
2.	Drying time a) Surface dry, max b) Hard dry, max c) Hard dry at 70^0 C	 4 hrs. 8 hrs. 30 minutes, with 15 minutes flash off time	IS:101-86(Part3/Sec.1), (Reaffirmed 2017) or latest version.
3.	Consistency	Smooth and uniform, and suitable for spray application(as per Chapter I, Para 3)	IS:101-89(Part1/Sec.5), (Reaffirmed 2019) or latest version.
4.	Finish	Smooth and full glossy	IS:101-87(Part3/Sec.4), (Reaffirmed 2019) or latest version.
5.	Colour	Close match to the specific IS **as in IS 5**/RAL colour or to an agreed colour where IS/RAL colour is not specified	IS:101-89(Part4/Sec.2), (Reaffirmed 2019) or latest version.
6.	Dry film thickness, per coat	(35-45)microns	IS:101-89(Part3/ Sec2), (Reaffirmed 2019) or latest version /By Elcometer
7.	Volume solids, % min	45.0	**APPENDIX-I**
8.	Scratch hardness (1.5 Kg Load)	No such scratch so as to show base metal	IS:101-88(Part5/Sec.2), (Reaffirmed 2019) or latest version.
9.	Flexibility & Adhesion (6.25 mm mandrel).	No visible damage or detachment of film	IS:101-88(Part5/Sec.2), (Reaffirmed 2019) or latest version.
10.	Flash point (a) Component 'A' (b) Component 'B'	 Above 20^0 C Above 20^0 C	IS:101-87(Part1/Sec.6), (Reaffirmed 2019) or latest version.
11.	Fineness of Grind, max	15 microns	IS:101-87(Part3/Sec.5), (Reaffirmed 2019) or latest version.

12.	Pot life (After induction time), min at a) (27 ± 2)°C b) (40 ± 2)°C	 3 ½ hrs 2 Hrs	APPENDIX-II
13.	Gloss at 60^0 angle of incidence, min	85 (for glossy finish)	IS:101-88(Part4/Sec.4), (Reaffirmed 2017)or latest version. Gloss should be checked after applying two coats of Heat Reflective &thermal barrier full gloss PU enamel.
14.	Mass in Kg/10 litres, Min	10.0	IS:101-87(Part1/Sec.7), (Reaffirmed 2019) or latest version.
15.	Keeping properties	Min. 12 months	APPENDIX-III
16.	Theoretical spreading rate, min	12.0 Sq. m./lt. at 35 micron DFT	APPENDIX-I
17.	Unreacted monomer, % by mass, Max	2.0	By Gas Chromatograph method in reference to ASTM D 4827 – 03
18	% Aliphatic Poly isocyanate by mass, in hardener	16.Min.	Appendix-VIII
19.	Viscosity (Efflux time by Ford cup No.4) of paint i.e. mix. Of two components at 27± 2^0C in Supply condition	60 Sec, Max	IS:101-89(Part1/Sec.5), (Reaffirmed 2019) or latest version.
20	Accelerated Tests (a) Resistance to 30% Sulphuric acid (weight by volume) Resistance to 20% caustic potash (weight by volume) Resistance to oil Resistance to solvents Resistance to tap water	The film shall not show any signs of blistering, wrinkling & lifting. Difference in gloss and colour between immersed & unimmersed area of painted panel shall be 70%, minimum and 7 out of 10 max. respectively -do- -do- -do- -do-	APPENDIX-V & VII
21	Humidity test.	No sign of corrosion & no sign of deterioration viz. blistering, detachment of film up to 500 hrs	IS:101-88(Part6/Sec.1), (Reaffirmed 2020) or latest version.

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*22	Solar Reflectance Performance on full paint system: (a)Solar Reflective Index-SRI (b)Emissivity Index (c)Total Solar Reflectance-TSR (c) Infra Red (IR)Rejection	(a) i) 102.0,Min (for white) ii) 50 - 90 (for others except Black) (b) 0.92,Min (c) 0.89,Min (d) >90%		(a)ASTM E-1980/ (b) EN 673/ASTM C 1371 (c)ISO-9050/ASTM C 1549/ ASTM E 903 (d) ASTM G 173
*23	R Value(Thermal Resistance)	0.80 m^2/K/W, Min		ASTM C 518
*24	Performance Test (Percentage reduction in temperature)	Minimum 15% of ambient temperature **(On Full paint system)**		APPENDIX-XIII
*25	Smoke & Fire Resistance	**R7 (HL3) (On Full paint system)**		EN-45545-2
26	Abrasion Resistance test for 1000 cycles with CS-17wheels & 1.0 Kg load	125 mg loss, Max		ASTM D-4060
27	Durability Tests Accelerated weathering test	Replaced as follows		APPENDIX-VI and relevant Assessment clause for Durability in IS: 13213.
		Degree of Blistering	0 (No blisters)	0 (No blisters)
		Degree of Rusting	Ri 0 (rusted area % zero)	Ri 0 (rusted area % zero)
		Degree of Cracking	0 (No detectable cracks)	0 (No detectable cracks)
		Degree of Flaking	0 (Flacked area % zero)	0 (Flacked area % zero)
		Degree of Chalking	0 (unchanged i.e. no perceptible chalking)	0 (unchanged i.e. no perceptible chalking)
		Degree of Spotting	7-8	7-8
		Degree of colour Change	Rating shall not be less than 7	Rating shall not be less than 7

		Gloss retention 60°, *Min*	90 percent of original	90 percent of original

***Note:** Test reports for Sr. No. 22, 23, 24 & 25 from MSME/NTH/CSIR/HBTU/Shri RAM Test House/NABL/NABCB accredited laboratory/ any other Govt. Lab. for Fire & smoke resistance properties and Solar reflectance performance properties shall be submitted during supply only.

TABLE II: DETAILS OF PREPARING PAINTED PANELS FOR HEAT REFLECTIVE &THERMAL BARRIER FULL GLOSS PU ENAMEL (TWO PACK)

Sl. No	Test	Type of metal panel	Unless specified otherwise, Size in mm (Ref: IS 101 (Part 1/Sec 3)	Painting detail	D.F.T	Method of application	Duration of air drying before commencement of test (Applicable for panels either air dried or dried at elevated temperature)	Special instructions
1.	Drying time	M.S. **as per IS:513-2016 or latest**	150 x 100 x 1.25	One coat of Heat Reflective & thermal barrier full gloss (2 component)	(35-45) microns	As per Chapter I, Para 3	-	-
2.	Finish	-do-	-do-	-do-	-do-	-do-	48 hrs.	-
3.	Colour	-do-	-do-	-do-	-do-	-do-	24 hrs.	-
4.	Dry film thickness	-do-	-do-	-do-	-do-	-do-	-do-	-
5.	Scratch Hardness	Tinned	150 x 50 x 0.315	-do-	-do-	-do-	7 days	Apply a load of 1.5 Kg. Instead of 1.0 Kg
6.	Flexibility & Adhesion	-Do-	-do-	-do-	-do-	-do-	-do-	-
7.	Gloss	M.S.**as per IS:513-2016 or latest**	150 x 100 x 1.25	Double coat of Heat Reflective & thermal barrier enamel full gloss (2 component)	(70-80) microns	-do-	24 hrs	-
8.	Accelerated tests (a) to (e)	M.S. **as per IS:513-2016 or latest**	150 x 100 x 1.25	Prepare and paint both sides of the panels as per Appendix-IV	Min. 230 microns	-do-	7 days	APPENDIX-V
	(a) Resistance to oil	-Do-	-Do-	--do--	Min 230 microns	-do-	-do-	-do-
	(b) Resistance to tap water	-Do-	-Do-	--do--	--do--	--do--	--do--	--do--
	(c) Resistance to solvents	-Do-	-Do-	Prepare and	--do--	-do-	--do--	-do-

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	(d) resistance to Alkali (e) Resistance to Acid	Glass panel -Do-	150 x 100 x 1.25 -Do-	paint only one side of the panels -do- -do-	Min. 230 microns -do-	-do- -do-	-do- -do-	-do- -do-
9.	Durability Test : Accelerated weathering test	M.S. **as per IS:513 -2016 or latest**	(i) 135 mmX40 mm X 1.25 mm for QUV (ii) 60 mm X 40 mm X1.25 mm for Xenon Arc **Or any other sizes as suitable for the equipment**	Prepare and paint both sides of the panels as per Appendix-IV	Min.230 microns	-do-	-do-	APPENDIX-VI
10.	Humidity Test	M.S. **as per IS:513 -2016 or latest**	(150 x 100 x 1.25) mm	Prepare and paint both sides of the panels as per APPENDIX-IV	Min.230 microns	-do-	-do-	APPENDIX - IV
11.	Abrasion resistance test	M.S. **as per IS:513 -2016 or latest**	(100 x 100 x 1.25) mm Centrally located hole of size as per specific design of the testing machine	Double coat of Heat Reflective &thermal barrier enamel full gloss (2 component)	(70-80) microns	-do-	-do-	-
12.	Solar Reflectance Performance on full paint system: (a)Solar Reflective Index-SRI (b)Emissivity Index (c)Total Solar Reflectance-TSR (d) Infra-Red (IR)Rejection	M.S. **as per IS:513 -2016 or latest**	(150 x 100 x 1.25) mm	Prepare and paint both sides of the panels as per APPENDIX-IV	Min.230 microns	-do-	-do-	(a)ASTM E-1980 (b) EN 673/ASTM C 1371 (c)ISO-9050/ASTM C 1549/ ASTM E 903 (d) ASTM G 173
13.	Smoke & Fire Resistance	M.S. **as per IS:513 -2016 or latest**	150 X150 X 1.25 mm	Prepare and paint both sides of the panels as per Appendix-IV	Min.230 microns	-do-	-do-	APPENDIX-VI
14.	Performance Test (Percentage reduction in temperature)	Oil / Grease barrel	(215 ltrs. Capacity)	Paint barrel as per Appendix-IV	Min.230 microns	-do-	-do-	Appendix-XIII

APPENDIX – I

PROCEDURE FOR DETEMINING VOLUME SOLIDS PERCENTAGE

1. SCOPE :

This method is applicable for determination of the volume solids percentage of paint coatings.

2. SIGNIFICANCE :

This method is intended to provide a measure of the volume of dry coating obtainable from a given volume of liquid coating. This volume is considered to be the most equitable means of comparing the coverage (sq metre of surface covered at a specific film thickness per unit volume) and also for calculating the wet film thickness of the given paint.

3. APPARATUS :

(i) Analytical Balance
(ii) Steel Disc – Preferably stainless steel, 60 mm dia and 0.70 mm thickness with a small hole 2 to 3 mm from the edge. A fine wire such as chromel is attached through the hole and made of the appropriate length for suspending the disc in a liquid.
(iii) Weight box
(iv) Beaker 1 litre for weighing the disc in liquid
(v) Weight per litre cup for determining the specific gravity of the paint material and of the suspending liquid if not known.
(vi) Oven

4. PROCEDURE :

(i) Dry the disc in an oven at 105°C for 10 minutes and cool.
(ii) Weight the disc in air. Let it be W1 grams.
(iii) Suspend the disc in water and weigh again. Let it be W2 grams.
(iv) Calculate the volume of the disc V as follows :

$$V = \frac{W1 - W2}{d}$$ where d is the density of the water at room temperature

(v) Determine the weight of non-volatile content of the liquid coating material by drying a known amount of paint at 105° C for 3 hours. Let it be W grams.

vi) Determine the specific gravity of the paint to the nearest 0.001 g/ml by using weight per gallon cup. Let it be P

iv) Dip the disc in the paint sample for 10 minutes and take out the disc and allow the excess coating material to drain off. Blot the coating material off the bottom edge of the disc so that heads or drops do not dry on the bottom edge of the disc.

v) Dry the disc in an oven for 3 hours at 105°C and cool.

vi) Weigh the coated disc in air. Let it be W_3 grams.

vii) Suspend the coated disc in water and weigh again. Let it be W_4 grams.

viii) Calculate the volume of the coated disc as follows :

$$V_1 = \frac{W_3 - W_4}{d}$$ where d is the density of the water at room temperature

viii) Calculate the volume of the dried coating as follows :-

Volume of dried coating (Vd) = V_1 - V

xiii) Calculate the volume of wet coating as follows :

$$V_w = \frac{W_3 - W_1}{W \times P}$$ where W = grams of non-volatile matter in 1 g of wet coating

P = specific gravity of the paint

xiv) Calculate the percentage volume solids of the paints as follows:

$$\frac{V1 - V}{Vw} \times 100 \quad (OR) \quad \frac{Vd}{Vw} \times 100$$

The volume of non-volatile matter or the percentage volume solids of a paint is related to the covering capacity and thickness in the following manner:-

(a) $$\frac{\text{\% Volume solids}}{\text{Dry film thickness (microns)}} \times 10 = \text{Covering Capacity}$$

b) $$\frac{\text{Dry film thickness (microns)}}{\text{\% Volume solid}} \times 100 = \text{wet film thickness(microns)}$$

APPENDIX – II

PROCEDURE FOR DETERMINING OF POT LIFE

(AS PER U.S. DEPTT. OF TRANSPORT/FED. RAIL, ROAD ADMN. OFFICE OF SAFETY TEST METHOD 2.7.1)

Take the usable time as the pot life of paint. Condition the components of the coating for one hour at $(27\pm 2)^0$ C and mix immediately in proper ratio to get approx. 200 ml. of paint in 250 ml. of container. The lid should be loosely placed on the container.

Measure the viscosity initially and every hour thereafter. However, the interval may be shortened, if desired.

Near the end of the paint's working life, the viscosity builds-up rapidly. During this period, when it appears the paint may be too viscous to spray, remove a small portion and add the appropriate thinner. If the paint can still be thinned, the end of the working life has not been reached. The end of the working life is reached when the paint gels, becomes stringy or cannot be thinned for application.

APPENDIX- III

KEEPING PROPERTIES

When stored under cover in a dry place in the original sealed containers under normal temperature conditions, the material shall detained the properties prescribed in the specification for the stipulated period from the date of manufacture which shall be subsequent to the date of placement of contract.

APPENDIX IV

PREPARATION OF TEST PANELS

1. In the painting procedure mentioned below, the air drying of the films shall be done at temperature of $(27\pm 2)^0$ C and a relative humidity of (65± 5)%.
2. The surface of the test panels as per M.S.as per IS:513 -2016 or latest to be exposed shall be prepared as follows, taking care that total dry film thickness of the complete system shall be minimum 190 microns.
3. Apply one coat of Epoxy Zinc Phosphate primer by suitable spraying as per Chapter I, Para 3 conforming to this specification, and allow it to air dry for 24 Hrs.
4. Rub down lightly with waterproof emery paper No.280/320, wipe off the surface using a piece of clean and dry soft cloth and then apply one coat of **thermal barrier high build epoxy** by suitable spraying as per Chapter I, Para 3 conforming to this specification, and allow it to air dry for 24 hrs.

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5. Rub down, wet with waterproof emery paper No.280/320, wipe off the surface using a piece of clean and dry soft cloth and then apply one coat of **heat reflective & thermal barrier** Full Gloss PU Enamel by suitable spraying as per Chapter I, Para 3, conforming to this specification, and allow it to air dry for 24 hrs.

6. Rub down, wet with waterproof emery paper No.220, wash and wipe off water and when the surface is dry, apply a second coat of **heat reflective & thermal barrier** full Gloss PU Enamel by suitable spraying, as per Chapter I, Para 3 conforming to this specification, and allow it to air dry for 07 days before subjecting to exposure test.

Note: The epoxy primer, **epoxy putty**, thermal barrier **high build epoxy** and heat reflective & thermal barrier full gloss PU enamel shall be from the same supplier to ensure compatibility.

APPENDIX-V

ACCELERATED TESTS
[Immersion Method — Follow the immersion method procedures as described in [IS:101(Part 7/Sec 2)].

The following short term tests of chemical resistance do not categorize the type of service for which polyurethane coating are intended but are included to assure the customer that the coating contains a sufficiency of cured resin to exhibit the long terms requirements.

Prepare the panels as per Appendix-IV allow the panels to air dry for seven days. For the immersion test as in (a), (b) and (c), prepare and paint both sides of the panels and protect the edges of the panels by sealing with a suitable wax.

a) **Resistance to Sulphuric Acid(See IS: 266):**
Immerse ¾th of the panel in 30% Sulphuric Acid (W/V) for 24 hours. Remove the panel, wash in running fresh water and allow it to dry for an hour and record the observation.

b) **Resistance to Caustic Potash (See IS 6831):**
Immerse ¾th of the panel in 20% Potassium Hydroxide (W/V) for 24 hours. Remove the panel, wash in running fresh water and allow it to dry for an hour and record the observation.

c) **Resistance to Oil:**
Prepare the panel as per Table 2. Immerse ¾th of the panel in a mineral lubricating oil (**having a viscosity of 18.0 centistokes or having a time flow of app. 80 seconds for 50 ml at 60 °C in a No. 1 Redwood viscometer**) for 2 hours. Remove the panel and wipe the excess oil with a pad of cotton and wash it with mineral turpentine oil (MTO) **as per IS:533 or IS:1745** and allow to dry for 30 minutes and record the observation.

d) Resistance to Solvents:

Test on panel each for resistance to xylene (See 1S:17370), ethanol (See IS: 323) and acetone (See IS: 170)respectively. Take white sterilized cotton and soak it in the solvent and place it on the painted panel without squeezing the cotton. Immediately cover the soaks cotton with a suitable watch glass and leave it for 3 hours. Remove the watch glass and then the soaked cotton and wipe the area with clean dry cotton and immediately record the observation.

e) Resistance to Tap Water:

Immerse ¾th of the panel in water for 240 hours. Remove the panel, wash in running fresh water and allow it to dry for an hour and record the observation.

For recording Observation:

(i) Evaluation method and Rating of Film Characteristics of immersed test panel (See Cl 3.1 to 3.8 in accordance with ISO: 4628, Appendix-VI)

(ii) Difference in colour between immersed and unimmersed area of painted panel shall be 7 out of 10 *Max.* respectively.

APPENDIX – VI

ACCELERATED TEST FOR DURABILITY
[*Table* 1, *SI No.* (27)]

DURABILITY TEST

1. **GENERAL**

Accelerated weatherometer test on paints being done to simulate and predict the effects of long-term exposure to various environmental conditions such as sunlight, moisture, temperature fluctuations, and other atmospheric elements.

2. **ACCELERATED WEATHERING TEST:**

Testing can be conducted using any of the three accelerated weathering apparatus, namely QUV-A, QUV-B, or Xenon Arc, with exposure times set at 1

500 hours, 750 hours and 1000 hours respectively. Both side of the panels for these tests shall be prepared as described Appendix-IV. Duplicate samples are to be tested in an appropriate accelerated weathering apparatus, as detailed in 2.1, 2.2 & 2.3.

For details of method of tests for both Xenon Arc and QUV-A/QUV-B apparatus, refer to IS 101 (Part 6/ Sec 5).

2.1 **Xenon Arc**— An artificial weathering apparatus of the xenon arc type for uniform and controlled exposure to the effects of heat, light and water.

2.1.1. Commonly used cycles and test conditions for Xenon Arc apparatus are given below:

a) Black panel temperature (63 ± 3) °C

b) Continuous exposure in light for 17 minutes and intermittent exposure to water spray for 3 minutes light and spray.

c) Irradiance 0.55 W/m^2/nm

d) Total exposure time is 1 000 h.

However, any other cycle may be used if mutually agreed upon between the purchaser and the supplier.

2.2. **QUV-B**

An artificial weathering apparatus of the QUV type for uniform and controlled exposure to the effects of UV and condensation.

1.2.1. Commonly used cycles and test conditions for UV type apparatus are given below:

1)	Lamp type	UV 313
2)	Test cycle	UV – (4 h at 60 ± 3°C) Condensation – (4 h at 50 ± 3°C)
3)	Irradiance	0.67 W/m2/nm
4)	UV-B wavelength (approx.)	313 nm
5)	Total exposure time	750 h

However, any other cycle may be used if mutually agreed upon between the purchaser and the supplier.

2.3 QUV-A

An artificial weathering apparatus of the QUV type for uniform and controlled exposure to the effects of UV and condensation.

2.3.1. Commonly used cycles and test conditions for UV type apparatus are given below:

1)	Lamp type	UV 313
2)	Test cycle	UV – (4 h at 60 ± 3°C) Condensation – (4 h at 50 ± 3°C)
3)	Irradiance	0.67 W/m2/nm

4) UV-B wavelength (approx.)	313 nm
5) Total exposure time	1500 h

However, any other cycle may be used if mutually agreed upon between the purchaser and the supplier.

3. Evaluation and Rating of Film Characteristics of Test Panel:

The test panels before and after the specified periods of exposure tests shall be assessed for the various film characteristics as prescribed in 3.1 to 3.8 below in accordance with ISO: 4628.

3.1 Degree of blistering:

The exposed panel shall be examined for the degree of blistering at the interval of 72 h (every third day) up to the stipulated exposed time in 2. The rating for the quantity (density) and size of the blister shall be provided by matching with the figures given in (ISO 4628 Part 2). For passing the sample there shall be no blisters observed both during the exposure period and after completing the stipulated time in the respective accelerated weatherometer.

3.2 Freedom from Rusting:

After exposure of the film is discontinued, examine for corrosion of the metal surface of the panel underneath by removing film. The paint film shall be removed by solvent type paint remover. When the film is softened by the paint remover it shall be removed by gently rubbing with cotton swab or waste jute taking care to remove adhering film of primer and/or undercoating. After removal of the film, the exposed metal shall be covered by thick mineral oil or petroleum jelly. The rating for the degree of rusting shall be provided by matching with the figures given in (ISO 4628 Part 3). For passing the sample there shall be no rusting after completing the stipulated time in the respective accelerated weatherometer.

3.3 Freedom from Cracking:

The exposed panel shall be examined for the degree of cracking at the interval of 72 h (every third day) up to the stipulated exposed time in 2. The rating for the quantity, size and depth of cracking shall be provided by matching with the figures given in (ISO 4628 Part 4). For passing the sample there shall be no cracks observed both during the exposure period and after completing the stipulated time in the respective accelerated weatherometer.

3.4 Freedom from Flaking :

The exposed panel shall be examined for the degree of flaking at the interval of 72 h (every third day) up to the stipulated exposed time in 2. The rating for the degree of flaking shall be provided by matching with the figures given in (ISO 4628 Part 5). For passing the sample there shall be no flaks observed both during the exposure period and after completing the stipulated time in the respective accelerated weatherometer.

3.5 Freedom from Chalking:

The exposed panel shall be examined for the degree of rusting at the end of stipulated exposed time in 2. The rating for the degree of chalking shall be provided by matching with the figures given in(ISO 4628 Part 7). For passing the sample there shall be no perceptible chalking after completing the stipulated time in the respective accelerated weatherometer.

3.6 Freedom from Spotting:

The exposed panel shall be examined for the degree of spotting at the interval of 72 h (every third day) up to the stipulated exposed time in 2. The rating for the degree of spotting shall be provided by assessing the film with the standard prepared film in accordance with the below given Table below. For passing the sample there shall be no spotting observed both during the exposure period and after completing the stipulated time in the respective accelerated weatherometer.

Table : Rating for the degree of spotting

(*Clause* 3.6)

Numerical Value	*Rating*
10	No spotting
9	Satisfactory
8-7	Slight spotting
6-5	Definite spotting
4-3	Bad spotting
2-1	Very bad spotting
0	Complete spotting

3.7 Degree of Colour Change:

The colour of the test panel shall be compared against the stipulated shade as given in IS 5 or any agreed standard sample between purchaser and supplier. The initial rating for a good colour match shall be 10. The colour retention on exposure shall be expressed and recorded as the abbreviation of the type of colour change followed by the numerical rating as given below Table below. For passing the sample the rating shall not be less than 7 for both during the exposure

period and after completing the stipulated time in the respective accelerated weatherometer.

Table : Numerical rating for degree of colour change

(*Clause*3.7)

Sl. No.	*Numerical Value*	*Rating*	*Type of Colour Change*
(1)	(2)	(3)	(4)
i)	10	Good match	D-Darkening
ii)	9	Satisfactory	F-Fading
iii)	8 to7	Slight colour change	B-Blueing
iv)	6 to 5	Definite colour change	R-Reddening
v)	4 to 3	Bad colour change	Y-Yellowing
vi)	2 to 1	Very bad colour change	L-Loss of colour
vii)	0	Complete colour change	

3.8 Gloss loss at 60°:

The exposed panel shall be examined for the loss of gloss at the interval of 72 h (every third day) up to the stipulated exposed time in 2. The percentage of gloss loss shall be calculated with the initial taken gloss value, for measurement of gloss IS 101 (Part 4/Sec 4) may be referred. For passing the sample loss of gloss shall not be more 10 percent (that is gloss retention more than 90 percent) both during the exposure period and after completing the stipulated time in the respective accelerated weatherometer.

APPENDIX –VII

METHOD OF IDENTIFYING AROMATIC AND ALIPHATIC ISOCYANATE

Chemistry differentiates between aromatic and aliphatic isocyanates. This differentiation is justified by the difference in properties between these compounds and between their reaction products. The difference in properties between aliphatic and aromatic isocyanates in found both with the mono and polyisocyanates and in the polyurethane paint film. Polyurethane films cured with aliphatic polyisocyanates show excellent resistance to yellowing on exposure to light and excellent retention of gloss in outdoor exposure unlike polyurethane film cured with aromatic polyisocyanates which show more or less marked yellowing from exposure to light and poor retention of gloss in outdoor exposure. This difference between aromatic and aliphatic polyisocyanates cured films makes uncomplicated identification method desirable.

PROCEDURE

For identifying aromatic and aliphatic isocyanate solutions (also frequently called "HARDENER" or "CATALYST SOLUTION") prepare an approx. 40-50% solution with acetone into 30 – 50 ml of this solution stir approx. 1 ml of 3% H2O2 solution in it. RESULTS Aliphatic polyisocyanates show no discoloration at all. Aromatic polyisocyanates show a light brown to a dark reddish – brown coloration after 5-10 minutes which deepens further in the course of several hours. Some aromatic isocyanates are commercially available as brown colored liquids thus identifiable even without conducting the above tests. Whereas all the aliphatic isocyanates and some of the aromatic isocyanates are commercially marketed as clear water white liquids thus necessitating the above identification method to be conducted.

APPENDIX – VIII

Standard Test Method for Isocyanate Groups in Urethane Materials or Prepolymers

1. PROCEDURE:

1.1- Weigh to 0.1 g a specimen containing approximately 1.1 milliequivalents of NCO (for example 1.0 g of prepolymer containing approximately 5% NCO) in a 250 ml Erlenmeyer flask.

1.2- Add 25 ml of dry toluene (Note 2), place a stopper in the flask, and swirl by hand or on a mechanical agitator to dissolve the prepolymer. Solution may be aided by warming in a hot plate.

Note:- If the polymer is insoluble, add 10 ml of dry, analytical made acetone to the toluene.

1.3- Using a pipette, add 25.00 ml of 0.1 N di-n-butylamine solution and continue swirling for 15 min. with stopper in place.

1.4- Add 100 ml of isopropyl alcohol and 4 to 6 drops of bromophenol blue indicator solution. Titrate with 0.1 N hydrochloric acid to a yellow end point.

1.5- Run a blank titration including all reagents above but omitting the specimen.

2. Calculations

2.1- Calculate the NCO content as follows :

$$NCO, \% = \frac{(B - V) \times N \times 0.0420]}{W} \times 100$$

Where :

B = Volume of HCl for titration of the blank, ml,
V = Volume of HCl for titration of the specimen, ml,
N = normality of HCl
0.0420 = mille equivalent weight of the NCO group, and
W = grams of specimen weight, g

APPENDIX-IX

DETERMINATION OF STOPPING PROPERTIES :

Outline of the method:

A M.S. panel as per IS: 513 or latest version is dented with a specified numbers of dents and then coated with epoxy based zinc phosphate primer followed by polyester based putty. It is then suitably examined at the dents for satisfactory Stopping properties.

Procedure:

Dent a 300 x 150 x 0.9 mm M.S. panel as per IS:513 or latest version with the help of blunt iron ball hammer and make 10 dents of about 3 mm diameter and 1 mm deep. The dents shall be so made that they are 50 mm away from the side of the panels and 50 mm apart from one another. Roughen the panel with emery paper no. 180. Wipe this with petroleum hydrocarbon solvent, 145/205 (low aromatic) (See IS: 1745- 2018) and allow to dry. Apply one coat of epoxy based zinc phosphate primer to produce (60-80) microns DFT and air dry for 8 hrs, minimum. Make 3 applications of epoxy putty giving an interval of not less than 8hrs. and not more than 24 hrs. between successive applications, each having dry film thickness of 350 microns, minimum. Keep the panel vertically.

The material shall be deemed to have passed the test if there is no sagging after 2 hours, after every application at the dents, it works hard in 8 hours and shows no sign of crack or shrinkage after 18 hours.

APPENDIX-X

DETERMINATION OF RUBBING PROPERTIES

Outline of the Method:

The material in a specified film thickness is applied on a M.S. panel as per IS:513 or latest version. The film when dry is tested for its rubbing properties by rubbing with abrasive paper.

PROCEDURE:

Take 300 x 150 x0.9 mm M.S. panel as per IS:513 or latest version Roughen the panel with emery paper no. 180. Wipe this with petroleum hydrocarbon solvent, 145/205 (low aromatic) (see IS: 1745- 2018) and allow to dry .Apply one coat of epoxy based zinc phosphate primer to produce minimum (60-80) microns DFT, air dry for 8 hrs, followed by one coat of polyester based putty having dry film thickness of 300 microns ,minimum.

The film prepared as above shall be suitable for dry rubbing with 150 grade paper and wet rubbing with 280 grade water proof abrasive paper without any clogging of the paper. After rubbing down, the surface shall not show defects like roughness, scratches, cracks, pin holes etc. Minor pin holes or scratches which will duly be filled by subsequent coat of PU under coat paint shall not be the cause for rejection.

APPENDIX-XI

DETERMINATION OF HOLD- OUT PROPERTY IN PAINT SYSTEM

1. **Outline of method**:

   The material is tested in a painting system and schedule simulating actual use. Finish with uniformity of colour and gloss is taken as criteria for having passed the test.

2. **Procedure:**
   A panel of 300x150x0.9 mm, M.S. panel as per IS: 513 or latest version with full paint system shall be prepared as described below:

a) Clean the surface either by shot or grit blast/ phosphating / any appropriate chemical treatment/roughen the panel with emery paper no. 180 and wipe this with petroleum hydrocarbon solvent, 145/205 (low aromatic) (see IS: 1745-1978) and allow to dry.

b) Apply one coat of epoxy based zinc phophate primer (two pack) , (60-80) microns DFT as per the specification and allow to air dry for 8 hours, minimum . Dry rub with emery paper no. 400 and wipe clean with a dry soft cloth.

c) Make 3 applications of epoxy putty with a suitable knife, each application having a dry film thickness of 350 microns, minimum , at an interval of not less than 8hrs. and not more than 24 hrs between successive applications. The overall dry film thickness of 3 applications shall be minimum 1000 microns. Allow the final coat to air dry for at least 8 hours and not more than 24 hours. Wet rub with 280 grade water proof abrasive paper and allow to dry.

d) Apply one coat of thermal barrier high build epoxy (two- pack) , (100-150) microns DFT , as per the specification. Allow to air dry for 8 hours, minimum. Dry rub with emery paper no. 400 and clean the surface.

e) Apply two coats of full gloss **heat reflective &thermal barrier** enamel (Two-pack)of (35-45) microns DFT per coat, as per the specification at an interval of 8 hours, minimum between 1st and 2nd coat. Allow to air dry for at least 48 hours before assessing the performance.

3.The material shall be deemed to have passed the test, if the resultant finish is uniform all over the surface with regard to gloss and colour. The gloss when measured shall have a value specified in the specification.

APPENDIX-XII

DETERMINATION OF ADHESION AND COMPATIBILITY INPAINT SYSTEM

1. **Outline of method**:
The material is tested in a painting system and schedule simulating actual use. Satisfactory adhesion and compatibility between the coats is taken as criteria for having passed the test.

3. **PROCEDURE:**

A panel 300x150x0.9 mm, M.S. panel as per IS: 513 or latest version, with full paint system shall be prepared as described below:

a) Clean the surface either by shot or **grit blast (See IS**: / Phosphating (See IS 3618) / any appropriate chemical treatment/ roughen the panel with emery paper no. 180 and wipe this with petroleum hydrocarbon solvent, 145/205 (Low Aromatic) (IS: 1745- 2018) and allow to dry.

b) Apply one coat of epoxy based zinc phosphate primer (two pack), (60-80) microns DFT as per the specification and allow to air dry for at least 8 hours, minimum. Dry rub with emery paper no. 400 and wipe clean with a dry soft cloth.

c) Make 3 applications of epoxy putty with a suitable knife, each application having a dry film thickness of 350 microns, minimum, at an interval of not less than 8hrs. and not more than 24 hrs between successive applications. The overall dry film thickness of 3 applications shall be minimum 1000 microns. Allow the final coat to air dry for at least 8 hours and not more than 24 hours. Wet rub with 280 grade water proof abrasive paper and allow to dry.

d) Spray/apply one coat of thermal barrier high build epoxy (Two- pack), (100-150) microns DFT, as per the specification. Allow to air dry for 8 hours, minimum .Dry rub with emery paper no. 400 and clean the surface.

e) Apply two coats of **heat reflective & thermal barrier** full gloss PU enamel (Two-pack), (35-45) microns DFT per coat, as per the specification at an interval of 8 hours, minimum between 1st and 2nd coat. Allow to air dry for at least 7 days before assessing the performance.

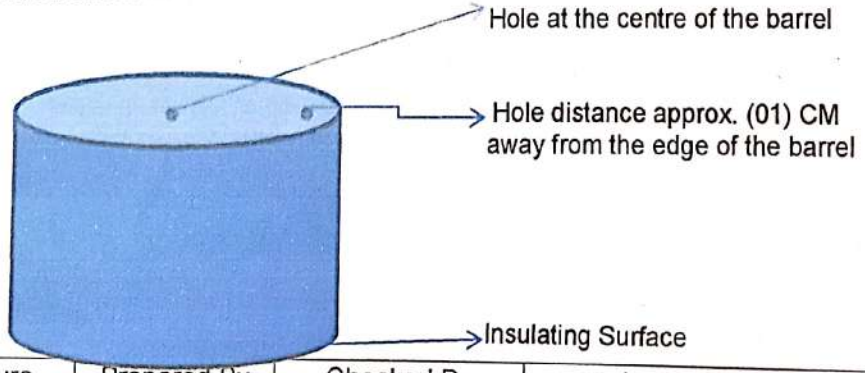
f) The material shall be deemed to have passed the test, if the material shows good adhesion over substrate and between various coats, and compatibility between epoxy primer, unsaturated polyester putty, thermal barrier PU surfacer, heat reflective & thermal barrier full gloss PU finish coat of the system.
This shall be assessed as per Test Method A- X Cut Tape Test of ASTM D 3359-09and the acceptance level of the test shall be 5A of the specification.

APPENDIX-XIII

PROCEDURE TO CHECK PERCENTAGE REDUCTION IN TEMPERATURE

a) Two empty oil/grease barrels (215 ltrs. Capacity each) shall be taken as one for reference and another for test barrel. Bottom side to be cut and open. Barrels shall be thoroughly cleaned with either by acetone (See 170) or by Petroleum Hydrocarbon Solvent (See IS:1745)

b) A small hole shall be made on center of the upper side portion of the barrels to be coated with heat reflective paint system to fix the thermometer for measuring the inside temperature of the barrel. Another hole is to be made at a distance approx. 1 cm from the edge of the circumference of barrel for recording temperature by radiation pyrometer/thermometer in parallel with the centrally fixed thermometer. Representative picture is shown below:-



Barrel Picture

c) Reference barrel shall be coated with full painting system (Epoxy primer + Unsaturated Polyester Putty + PU Surfacer + PU Full gloss Enamel) as per the existing paint system of RDSO specification no. M&C/PCN/100/2018 (Appendix-IV) and similar arrangement of holes shall be made on reference barrel for recording temperature and comparison purpose.

d) Another test barrel shall be coated with full painting system (Epoxy primer + Epoxy Putty + Thermal Barrier High Build Epoxy + Heat Reflecting & Thermal Barrier PU Full gloss Enamel) as per Draft RDSO specification no. M&C/PCN/100/2024.

e) Both barrels (Reference & Test barrel) are allowed to cure for 07 days.

f) Both the barrels shall be kept vertically on heat insulating blocks under direct sun light on a bright sunny day for four hours preferably between 11 AM to 03 PM.

g) Reading shall be observed once in 30 minutes in ^{0}C for both the barrels and recorded accordingly.

h) Surface temperature on the top and side exterior surface of the barrel coated with existing RDSO specification no. M&C/PCN/100/2018 and Draft RDSO specification no. M&C/PCN/100/2024 respectively shall be measured by radiation pyrometer. Temperature of air inside barrel surface shall be measured by thermometer as well as on the side surface and Centre of barrels.

i) After completion of test for a period of four hours, % reduction in temperature in test barrel shall be recorded and it should be minimum 15% to that of barrel coated with paint system as per RDSO specification no. M&C/PCN/100/2018.painted barrel.

ANNEXURE- XIV

HEALTH HAZARDS AND SAFETY MEASURES

Use of polyurethane paints generally presents a two-fold potential hazard, toxic hazards and fire hazards. Toxic effects through the lungs and the skin occur frequently in the industrial usage of paints. The best guide of comparative values of ingestion toxicity is the LD 50 value. It refers to the lethal doses of toxic substance which can kill 50 percent of one class of animal in test. The LD 50 value for polyisocyanates is much lower when compared to the LD 50 value of cyanides. Another guide of comparative values of inhalation is the threshold limit value (TLV). The TLV for monomeric di-isocyanates has been fixed up at 0.02 ppm. Therefore, spraying of polyurethane paints calls for safety precautions in the form of proper ventilation, proper exhaust facilities and hand-gloves for the spray painters. However, it would be an ideal painting practice to go in for proper spray booth.

APPENDIX-XV

QUANTITY FOR EACH TYPE OF PAINTING MATERIAL IN LITRES REQUIRED PER COACH SET FOR DIFFERENT TYPES OF COACHES

(For information only)

SN	Different Components of PU Paint to RDSO Specn No. M&C/PCN/100/2013	Quantity (in liters) per set for different types of Coaches							
		Conventional Coaches(with Aluminum Paint)	MEMU Driver Motor Coaches	LHB Type Power Car Coaches	LHB Type Rajdhani Coaches	Conventional Coaches (without Aluminum Paint)	MEMU Trailer Coaches	Parcel Van Coaches	LHB Type Shatabdi Coaches
1.	Epoxy Zinc Phosphate Primer (two packs)	52.00	52.00	200.00	200	52.00	52.00	52.00	200
2.	Unsaturated Polyester based Knifing Putty (two packs)	40.00 Kg	40.00 Kg	70.00 Kg	70.00 Kg	40.00 Kg	40.00 Kg	40.00 Kg	70 Kg
3.	PU Surfacer (two packs)	34.00	34.00	45.00	45.00	34.00	34.00	50.00	45.00
4.	PU Paint Aircraft Blue Finish to ISC-108 to IS:5-1994 (two packs)	35.00	20.00	-	-	35.00	14.00	46.00	-
	PU Paint Satin Blue Finish to ISC-177 of IS:5-1994 (two packs)	14.00	-	-	-	12.00	-	14.00	-
	PU Paint Pale Cream to ISC-352 of IS:5-1994 (two packs)	-	40.00	-	-	-	40.00	-	-
	PU Paint Black (two packs)	-	8.00	-	-	-	16.00	-	-
	PU Based Top Coat Color Signal Red to ISC-537 of IS:5-1994 (two packs)	-	2.00	3.00	25.00	-	-	-	-
	Different	Quantity (in liters) per set for different types of Coaches							

Signature	Prepared By	Checked By	Approved By
Name & Designation			

	Components of PU Paint to RDSO Specn No. M&C/PCN/100/2013	Conventional Coaches(with Aluminum Paint)	MEMU Driver Motor Coaches	LHB Type Power Car Coaches	LHB Type Rajdhani Coaches	Conventional Coaches (without Aluminum Paint)	MEMU Trailer Coaches	Parcel Van Coaches	LHB Type Shatabdi Coaches
	PU Based Top Coat Color Grey to RAL7001	-	-	72.00	47.00	-	-	-	-
	PU Based Top Coat Color Grey to RAL DS 240 60 05	-	-	-	-	-	-	-	60.00
	PU Based Top Coat (two packs) Color Satin Blue to RAL DS 240 6035	-	-	3.00	-	-	-	-	-
	PU Based Top Coat (two packs) Color Blue to RAL DS 260 6035	-	-	-	-	-	-	-	35.00
	PU Paint Off White to ICI Shade No. 28-1004	-	-	-	-	-	-	2.00	-
5.	Thinner for Epoxy Paint compatible with Epoxy Primer & Putty	20.00	20.00	40.00	40.00	20.00	20.00	20.00	40.00
6.	Thinner for PU Paint compatible with PU Top Coats	50.00	50.00	65.00	65.00	50.00	50.00	50.00	65.00

N.B."All the provisions contained in RDSO's procedures laid down in Document No.QOD-7.1-11 of latest aversion applicable (Titled "vendor –changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways".

Signature	Prepared By	Checked By	Approved By
Name & Designation			