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**RDSO SPECIFICATION No.
M&C/PCN/125/2020
(Rev 1.0)**



**SPECIFICATION FOR ZINC FILM
GALVANIZATION TO IMPART CORROSION
PROTECTION**

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SPECIFICATION FOR ZINC FILM GALVANIZATION TO IMPART CORROSION PROTECTION

1.0 SCOPE

This specification prescribes the technical details, methods of testing and criteria for the acceptance for Zinc rich coating loaded with fine, lamellar and spherical zinc particles blended in neutral resins to impart sacrificial and barrier protection against corrosion of steel components exposed in severe corrosive environments. This material is a high quality metallic zinc protective system for ferrous metals using the protection of galvanizing for long life protection against corrosion. The coating shall be suitable to protect Rails, Bridges & Structures, Towers, Pillars, Reinforcement Bars, Coaches & Wagons etc. The coating can be used on new/old structures prepared with surface finish equivalent to Sa 2.5 of ISO specification No. 8501-1-2007. The coating shall be suitable for application by Airless/Air Spraying, Brushing or Dipping by properly maintaining the specific gravity of liquid coating using organic solvents. The material is suitable for over coating with Epoxy and/or Polyurethane based coatings. The material as per this specification is not suitable for over coating with any alkyd based coating. Items coated with this type of coating should never be used in immersed conditions above 65⁰C. However, under non immersed conditions, the material can be used up to 150⁰C.

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.

2.0 TERMINOLOGY

- 2.1** For the purpose of this standard the Glossary of Terms mentioned in IS: 1303-83, Reaffirmed 2017 or its latest version , IS: 13229-92 or its latest version & IS: 209-92 or its latest version shall be applicable. In addition to this the following shall also apply.
- 2.2** Fine spherical and lamellar Zinc particles. The term fine used for Zinc particles having diameter, length and breadth in the range of (5-15) μm. Lamellar means that the particles will have higher length than the breadth.

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2.3 Barrier protection: Corrosion protection due to formation of an impervious layer of film of corrosion resistant products and resins on the substrate surface.

2.4 Sacrificial protection: Protection from corrosion of steel substrate due to dissolution of zinc and supplying electrons to the steel substrate.

2.5 The application of this type of coating derives the benefits of galvanizing and the process is known as cold galvanizing.

3.0 REQUIREMENTS

3.1 The coating system shall be based on One Pack supply.

3.2 A separate pack of solvent shall be supplied to adjust the specific gravity of the material as per requirements of dry film thickness.

3.3 Composition of the Material shall be as follows.

3.3.1 The Material shall consist of 93.0% by mass, minimum of Zinc dust.

3.3.2 The purity of zinc dust to be used in the formulation of the material shall be of 99.00 %, Min.

3.3.3 The material shall consist of 7.0 % by mass, maximum of Synthetic Resin and solvents.

4.0 PROPERTIES

GENERAL:

4.1 The material shall comply with the requirements specified in Clause 3.0 and TABLE-I of this specification. The latest specification should be taken into consideration where ever applicable.

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

4.2.1 The preparation of steel panels shall be in accordance with IS: 101 (Pt.1/Sec.3)-86 Reaffirmed 2012 or its latest version.

4.2.2 Unless otherwise stated all the tests shall be conducted at room temperature $(27\pm 2)^{\circ}\text{C}$ and Relative Humidity at $(65\pm 5)\%$ in a well-ventilated chamber free from draughts and dust.

4.2.3 The temperature of the surface to be coated must be at least 3°C above the dew point, to prevent moisture condensation.

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Table-I: REQUIREMENTS FOR ZINC FILM GALVANIZATION TO IMPART CORROSION PROTECTION

SN	Characteristics	Requirements	Method of test
1.	Drying Time a) Surface /Touch Dry, Max. b) Hard Dry/Recoating time, Max.	10 Minutes 60 Minutes	IS:101 (Pt.3/Sec.1)-86, Reaffirmed 2017 or its latest version
2.	Consistency (Efflux time by Ford Cup No. 4) at (27±2) ⁰ C	40-50 Second	IS:101 (Pt.1/Sec.5)-89, Reaffirmed 2019 or its latest version
3.	Colour	Grey (Zinc)	IS:101 (Pt.4/Sec.2)-89, Reaffirmed 2019 or its latest version
4.	Finish	Matt	IS:101 (Pt.3/Sec.4)-87, Reaffirmed 2019 or its latest version
5.	Adhesion test (Cross cut Tape Test)	Coating from none of the squares of the lattice shall be removed. Rate of adhesion matches to 5B grade	Test Method- B of ASTM D-3359
6.	Residue on sieve of 45 mesh (32 µm), % by mass, Max.	2.5	IS:101 (Pt.8/Sec.1)-89, Reaffirmed 2019 or its latest version
7.	Mass in Kg./10 liters	26.0-27.0	IS:101 (Pt.1/Sec.7)-87, Reaffirmed 2019 or its latest version
8.	Volume of Solids,%	55.0-60.0	IS:101 (Pt.8/Sec.6)-92, Reaffirmed 2019 or its latest version
9.	Dry Film Thickness per coat, by Brush/Spray	(40±5) µm	IS:101 (Pt.3/Sec.2)-89 Reaffirmed 2019/By Elcometer/ Thickness Gauge Meter
10.	Flash Paint, not less than	45 ⁰ C	IS:101 (Pt.1/Sec.6)-87, Reaffirmed 2019 or its latest version
11.	Covering Capacity, m ² /litre at 40 µm D.F.T., min. a) By Spraying b) By Brushing	10.5-11.0 9.5-10.00	IS:101 (Pt.4 /Sec.1)-88, Reaffirmed 2019 or its latest version
12.	Resistance to temperature at (i) -10 ⁰ C, for 2 hrs (ii) +160 ⁰ C, for 2 hrs.	There shall be no peeling, cracking, blistering, abnormal discolouration or loss of adhesion of the coating	IS:101 (Pt.7 /Sec.3)-90, Reaffirmed 2015 or its latest version

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13.	*Resistance to Immersion Tests (static) a) Distilled water b) 3.5 % (w/v) Sodium Chloride soln.	a) No trace of brown rusting for 2000 Hours b) No trace of brown rusting for 1000 hours	APPENDIX- I
14.	*Resistance to Salt Spray with 5 % (w/v) Sodium Chloride Solution at ambient temp.	No sign of brown rusting up to 2000 Hours	ASTM B-117
15.	*Protection against corrosion under conditions of condensation	No sign of brown rusting up to 2000 Hours	IS:101 (Pt.6 /Sec.1)-88, Reaffirmed 2015 or its latest version
16.	*Resistance to Sulphur Di-Oxide test 500 bubbles per 24 hrs.	No sign of brown rusting up to 500 Hours	Clause -7 of IS: 10493-83or its latest version
17.	*Potential - Time variation in 1% (w/v) Sodium chloride solution	Potential shall remain active more than -900 mv (saturated calomel electrode) up to 2000 Hours	APPENDIX -II
18.	*Static exposure in simulated concrete pore solution	No brown rusting up to 2000 Hours of exposure	APPENDIX -III
19.	*Galvanic corrosion tests	Equilibrium shall be attained	ASTM -G- 71
20.	a) 3.5% Sodium Chloride solution b) Artificial concrete pore solution containing 0.1M Sodium chloride	within a) 10 Second b) 30 Second	IS: 101(Pt.8 /Sec.2)-90 Reaffirmed 2017or its latest version by using Petroleum Hydrocarbon Solvent to IS:1745- 2018 (Third Revision) or its latest version
21.	Metallic Zinc content, % by Mass, min. (Pigment content in Paste)	93.0	APPENDIX –IV
22.	*Purity of Zinc, % by mass, min.	99.00	Appendix-IV
23.	Keeping Properties	Not less than 5 years	IS:101 (Pt.6 /Sec.2)89,RA-2019
24.	Durability Tests Accelerated weathering test as per ASTM- G- 154	Rating scale : (0-10)	APPENDIX-V
		Chalking 10	
		Checking 10	
		Cracking 10	
		Flaking 10	
		Spotting 10	
		Blistering 10	
		Corrosion No corrosion	
Colour change 7			
25.	Abrasion resistance-1000 Cycle with CS-17 wheels of 1.0 kg weight	125 mg loss, Max	ASTM -D-4060

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11.	Protection against corrosion under conditions of condensation	-do-	-do-	-do-	-do-	-do-	-do-	-do-
12.	Resistance to Sulphur dioxide test.	-do-	100x75 x1.25	-do-	-do-	-do-	-do-	-do-
13.	Durability Tests Accelerated weathering test	-do-	-do-	-do-	-do-	-do-	-do-	-
14.	Abrasion Resistance-1000 Cycle-	-do-	-do-	-do-	-do-	-do-	-do-	-

5.0 PACKING AND MARKING

5.1 Material shall be supplied in 2 to 20 liters steel containers as per requirements conforming to IS: 2552 or its latest version.

5.2 Each container shall be marked with following details.

- (a) Name of the Material
- (b) Source of Manufacturer
- (c) Volume of Material
- (d) Weight of Material
- (e) Lot No.
- (f) Month and year of Manufacturer and Temperature to be stored at.

5.3 Small Pack of 1 liter shall be supplied for patch up/touch up work.

6.0 INSPECTION

6.1 Full testing shall be performed at the time of initial approval.

6.2 In case of Acceptance testing, the Inspecting Authority shall draw the sample from ready batches as per IS:101(Pt.1/Sec.1)-1986(Reaffirmed 2017) or its latest version and tests shall be performed as per TABLE- I except long duration tests marked*.

6.3 For Bulk Supply, frequency of full testing of the product as per TABLE-I may be decided by the Purchaser.

7.0 QUALITY OF REAGENTS: Unless otherwise specified, pure chemicals and distilled water shall be employed in tests.

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APPENDIX-I

RESISTANCE TO IMMERSION TEST (STATIC)

This test shall be performed in triplicate, on steel panels prepared as per clause 8 of TABLE-II.

- a) **Resistance to Distilled Water:** The panels shall be immersed completely in glass beakers of suitable size containing distilled water. Mark the water level on beaker. The beakers shall be covered with lid of watch glasses to avoid excess evaporation of water. The panels shall remain under static condition for 4000 hours. Distilled water shall be added to compensate any evaporation loss during the test period. After 4000 hours of testing, coated panels shall not show any trace of brown rust.
- b) **Resistance to 3.5 % (w/v) Sodium Chloride:** The panels shall be immersed completely in glass beakers of suitable size containing 3.5 % (w/v) Sodium Chloride solution. Mark the solution level on beaker. The beakers shall be covered with lid of watch glasses to avoid excess evaporation of solution. The panels shall remain under static condition for 1000 hours. Distilled water shall be added to compensate any evaporation loss during the test period. After 1000 hours of testing, coated panels shall not show any trace of brown rust.

APPENDIX-II

POTENTIAL-TIME VARIATION TEST

This test shall be performed on panels prepared as per clause 9 of TABLE-II.

7-cm length of the panels shall be exposed in 3.5% (w/v) Sodium Chloride solution. The interface between the solution and air shall be coated with paraffin wax, so that air-solution interface does not come in contact with test electrolyte. A crocodile clip connected with insulated copper wire shall be used to make connection of immersed coated panels with a high impedance voltmeter. One of the lead shall be clipped at the

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top portion of the panels. A saturated calomel electrode shall be used as the reference electrode to measure the corrosion potential of coated panels. The saturated Calomel electrode shall be kept in a separate beaker having saturated KCl solution and electrolytic contact between the test solution (3.5% (w/v) NaCl solution) and Calomel electrode shall be made by putting two ends of salt bridge in these two beakers. A high impedance voltmeter shall be used to measure the potential developed between the coated panels and calomel electrode. The negative lead of voltmeter shall be connected to the Calomel electrode and the positive lead to the coated panel. The potential shall be measured after every eight hours of exposure and should continue minimum for 2000 hours. During this period of test the potential shall not come more than -900 mV (Saturated Calomel electrode).

APPENDIX – III

TEST FOR STATIC EXPOSURE IN SIMULATED CONCRETE PORE SOLUTION

The steel panels of 150 mm x 100 mm x 1.25 mm coated with zinc coating shall be exposed in simulated concrete pore solution. The composition of simulated pore solution shall be as follows:

0.06 M Potassium Hydroxide (KOH),

0.2 M Sodium hydroxide (NaOH) and

0.001M Calcium Hydroxide

[Ca(OH)₂].

1% (w/v) Sodium Chloride shall be added in the test electrolyte prepared.

The coated panels shall be kept immersed in this solution under static conditions. The evaporation losses of the solution during the test period shall be compensated by adding distilled water. Minimum 4 identically coated panels shall be tested simultaneously. No trace of brown rust shall be visible on at least 3 panels during 2000 hours of the immersion of the test panels.

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APPENDIX-IV

DETERMINATION OF PURITY OF ZINC

Take out about 14.08 cm² of zinc rich galvanized coated plate/ rebar and put in a glass container having solvent supplied with paint under constant stirring till all zinc coating is stripped out in solution. Take out the sample with a steel tong and rub gently with a hair brush and wash it with solvent till complete zinc is removed from the surface. Filter out the solution and take out filtrate on a watch glass. Dry the filtrate in an oven maintained at the temperature of about 80°C for one hour. Take out the dry material and weigh approximately 1 gm of the dry powder on a watch glass .Transfer it in a beaker and dissolve in about 25 ml. of HCl (1.5) solution. Heat it at (70- 75)°C till all powder material is dissolved in acid solution.

Transfer this solution to 500 ml of a measuring (volumetric) flask and make up to the mark with distilled water. Shake well to get uniform solution and take it as aliquot .Take 10 ml of this aliquot sample solution in a conical flask and add 50 ml of distilled water. Add 5ml of NH₄F (10 % solution) and maintain pH 5 by adding NH₄OH (1.5) or HCl (1.5) (which ever is necessary) drop by drop. Add 10 ml of sodium acetate buffer solution having pH= 5 and 7 to 8 drops of xylenol orange (indicator) .Colour changes to purple. Boil for 5 minutes and cool it. Titrate against 0.025 M Di sodium salt of EDTA. The colour changes from purple to yellow.

PREPARATION OF REAGENTS:

Sodium Acetate Buffer Solution: 22.0 gm of sodium acetate in 30 ml of distilled water + 2 ml of glacial acetic acid and make up to 1000 ml.

Xylenol Orange (Indicator): Take 0.3 gm of solid xylenol orange (Thomas Baker company or INDI KROM company) + 100 ml of dist. Water + 1 drop HCl to get red colour.

0.25 M EDTA Di Sodium salt (AR Grade): Mol. wt.of di-sodium salt EDTA is 372.2 gm. Dissolve 9.305 gm of EDTA di sodium salt to get 1000 ml solution in distilled water.

Calculation :

$$\% \text{ Zn} = \frac{0.065339 \times 2.5 \times 50 \times \text{titrate value}}{\text{weight of unknown zinc containing material in gm}}$$

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Basis of calculation:

1000 ml of 1 M EDTA- Di sodium salt \equiv 65.3 gm of Zinc.

Or 1 ml of 1 M EDTA – Disodium salt \equiv 0.0653 gm zinc.

Or 1 ml of 0.025 M EDTA-Disodium salt salt \equiv 0.0016325 gm of zinc.

Therefore , in 500 ml solution , the zinc content should be

$$= 500 \times 0.0016325 = 0.81625 \text{ gms.}$$

APPENDIX – V

ACCELERATED TEST FOR DURABILITY

Both sides of the panels must be prepared and painted as per TABLE-II S.No.13.

a) ACCELERATED WEATHERING TEST

The test is performed according to DIN53387

- Test Period : 1000 hours
- Apparatus : Weather-o-meter, Xenon Arc Lamp with rotating day/night device type
- Cycle : 3 Min. rainfall, 17 Min. dry period alternatively
- Light exposure : UVB 313 light exposure
- Temperature : 50°C

The requirements of this test shall be taken to have been satisfied if performance in respect of the characteristics as noted in of IS 8662: 2004 (Second Revision) Reaffirmed-2019 (or corresponding clause of latest version) is within the limits.

b) ALTERNATE METHOD

The test may also be carried out as per ASTM-G-154

- Test Period : 750 hours
- Apparatus : Operating Light and Water-Exposure Apparatus (Fluorescent UV-Condensation Type)
- Cycle : 4 Hrs. U.V. Light from UV-B lamps with a peak emission @ 313 nm. and 4 hrs Condensation alternatively.
- Temperature : 50°C

The requirements of this test shall be taken to have been satisfied if performance in respect of the characteristics as noted in IS 8662: 2004 (Second Revision) Reaffirmed-2019 (or corresponding clause of its latest version) is within the limits.