

*Issued to M/s SRMB Srijan Ltd
Kolkata*

**RDSO SPECIFICATION
No. M&C/PCN/125-2009**

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21/12/09

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

**RESEARCH DESIGNS & STANDARDS ORGANISATION
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RDSO SPECIFICATION No. M&C/PCN/125-2009 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. 8501-1-88. 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.

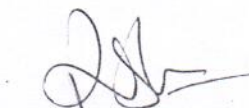
The material is suitable for over coating with epoxy and/or polyurethane based coatings.


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 65 °C. However, under non immersed conditions, the material can be used up to 150°C.

2.0 TERMINOLOGY

- 2.1 For the purpose of this standard the glossary of terms mentioned in IS: 1303-83, IS: 13229-92 & IS: 209-92 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.
- 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.


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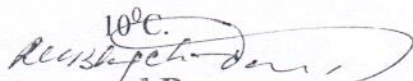
- 2.4 Sacrificial protection: Protection from corrosion of steel substrate due to dissolution of zinc and supplying electrons to the steel substrate.
- 2.5 The application of this type of coating derives the benefits of galvanizing and the process is known as cold galvanizing.

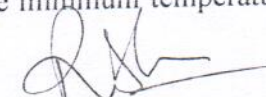
3.0 REQUIREMENTS

- 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

- 4.1 **General:** 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 Cl.2 of IS:101 (Pt.1/Sec.3)-87.
- 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. The minimum temperature for satisfactory cure shall be


10°C.

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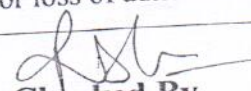

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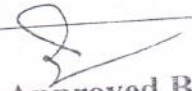

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Table I: REQUIREMENTS FOR ZINC FILM GALVANIZATION TO IMPART
CORROSION PROTECTION

S. No.	Characteristics	Requirements	Method of test
11.	Drying time a) Surface /Touch dry, max. b) Hard dry/Recoating time, max.	10 minutes 60 minutes	IS:101 (Pt.3/Sec.1)-86
2.	Consistency (Efflux time) at $27 \pm 2^{\circ}\text{C}$	40-50 sec	IS:101 (Pt.1/Sec.5)-89
3.	Colour	Grey (Zinc)	IS:101 (Pt.4/Sec.2)-89
4.	Finish	Matt	IS:101 (Pt.3/Sec.4)-87
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 ($32 \mu\text{m}$), % by mass, max.	2.5	IS:101 (Pt.8/Sec.1)-89
7.	Mass in Kg./10 liters	26.0-27.0	IS:101 (Pt.1/Sec.7)-87
8.	Volume of solids,%	55.0-60.0	IS:101 (Pt.8/Sec.6)-92
9.	Dry film thickness per coat, by brush/spray	$40 \pm 5 \mu\text{m}$	IS:101 (Pt.3/Sec.2)-89 By thickness gauge meter
10.	Flash point, not less than	45°C	IS:101 (Pt.1/Sec.6)-87
11.	Covering capacity, m^2/litre at $40 \mu\text{m}$ 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
12.	Resistance to temperature at (i) -10°C , for 2 hrs (ii) $+160^{\circ}\text{C}$, 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


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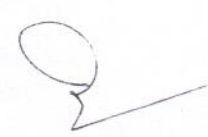
13.	*Necessitate to Immersion tests (static) a) Distilled water b) 3.5 % (w/v) Sodium chloride soln.	a) No trace of brown rusting for 2000 hours b) No trace of brown rusting for 1000 hours	Appendix-II
14.	*Resistance to Salt spray with 5 % (w/v) Sodium Chloride Solution at ambient temperature	No sign 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
16.	*Resistance to Sulphur di-oxide test 500 bubbles per 24 hrs.	No sign of brown rusting up to 500 hours	IS: 10493-83,C1.7
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 a) 3.5% Sodium chloride solution b) Artificial concrete pore solution containing 0.1M Sodium chloride	Equilibrium shall be attained within a) 10 sec. b) 30 sec.	ASTM G- 71



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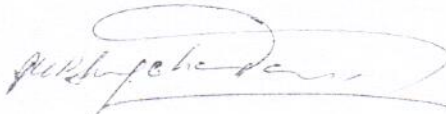
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20.	Metallic zinc content, % by mass, min. (Pigment content in Paste)	93.0	IS: 101 (Pt 8 / Sec 2) - 90 by using Petroleum Hydrocarbon Solvent to IS: 1745	
21.	Purity of zinc, % by mass, min.	99.00	Appendix-IV	
22.	Abrasion resistance-1000 Cycle	125 mg loss, max Rating scale 0-10	As per ASTM D-4060	
23.	*Durability Tests Accelerated weathering test as per ASTM G53 - 88	Chalking	10	Appendix-V
		Checking	10	
		Cracking	10	
		Flaking	10	
		Spotting	10	
		Blistering	10	
		Corrosion	No corrosion	
Colour change	7			

In case of initial approval/inspection of the product all the tests mentioned in Table-I should be performed on the product as per cl. No6.

Note: (I) Where ever required, the edges of the test panels may be rescaled with wax if these gets damaged/thinned down during testing period.

(II) Above tests are to be performed in triplicate and two data close to each other are to be accepted.


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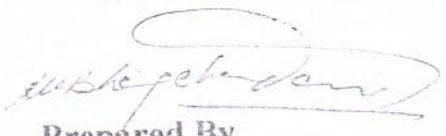

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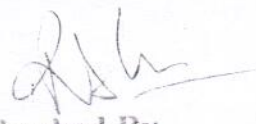
TABLE-II

**DETAILS OF PREPARING COATED PANELS FOR TESTING OF ZINC FILM
GALVANIZATION TO IMPART CORROSION PROTECTION**


SS. No	Test	Type of Metal Panel	Size in m.m.	Painting Detail	DFT	Method of Application	Duration of Air Drying before commencement of test	Special Instruction
1.	Drying Time	M.S.	150 x 100 x 1.25	One coat of zinc film galvanization	40±5 microns	Brush/Spray	-	-
2.	Finish	-do-	-do-	-do-	-do-	-do-	24 Hours	-
3.	Colour	-do-	-do-	-do-	-do-	-do-	24 Hours	-
4.	Gloss	-do-	-do-	-do-	-do-	-do-	24 Hours	-
5.	Dry Film thickness a) By brush b) By airless spray	-do- -do-	-do- -do-	-do- -do-	-do- -do-	Brush Spray	-do- -do-	- -
6.	Adhesion test (Cross cut Tape Test)	-do-	-do-	-do-	-do-	-do-	24 Hours	-
7.	Resistance to temperature	M.S.	150 x 100 x 1.25	One coat of zinc film galvanization	40±5 microns	Brush/Spray	-	-
8.	Resistance to immersion tests	-do-	-do-	-do-	-do-	-do-	-do-	Coat both sides of panels and seal the edges with wax



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9).	Potential-- Time variation test	-do-	-do-	-do-	-do-	-do-	-do-	-do-
10.	Resistance to Salt Spray	-do-	-do-	-do-	-do-	-do-	-do-	-do-
11.	Protection against corrosion under conditions of condensatio n	-do-	-do-	-do-	-do-	-do-	-do-	-do-
12.	Resistance to Sulphur di-oxide test.	-do-	100x75 x1.25	-do-	-do-	-do-	-do-	-do-
13.	Durability Tests Accelerated weathering test	-do-	-do-	-do-	-do-	-do-	-do-	-


5.0 MARKING AND PACKING


5.1 Material shall be supplied in 2 to 20 liters steel containers as per requirements


Conforming to IS: 2552.

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 ,sheif life and temperature to be stored at


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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 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.

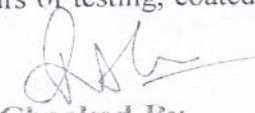
APPENDIX-I

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.


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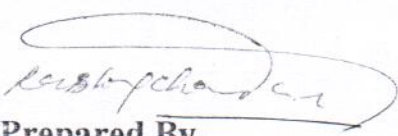


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APPENDIX-IIPotential-Time variation Test

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 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).


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APPENDIX – IIITest 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

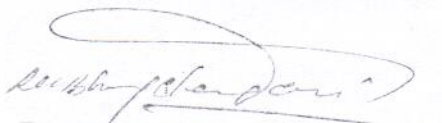
0.001M Calcium hydroxide [Ca(OH)₂].


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.

APPENDIX-IVDetermination 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.


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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.

0.025 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 :

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

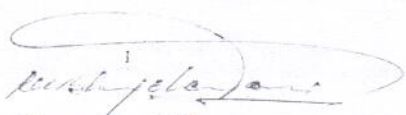
Basis of calculation :

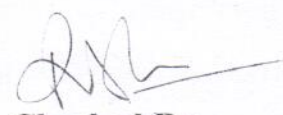
1000 ml of 1 M EDTA- Di sodium salt \equiv 65.3 gm of Zinc.

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


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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 Clause D-3.2 of IS : 8662-1993 (or corresponding clause of latest version) is within the limits.


b) ALTERNATE METHOD


The test may also be carried out as per ASTM-G-53

- 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 n.m. 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 Clause D-3.2 of IS : 8662-1993(or corresponding clause of latest version) is within the limits.

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