Specification No. ETI/OHE/13 (4/84)

Specification for Hot Dip Zinc Galvanization of Steel Mast, (Rolled & Fabricated) Tubes & Fittings used on 25 kV AC OHE.

1. SCOPE

1.1 This standard specifies the requirement of zinc coating on rolled / fabricated masts, tubes and fittings applied by hot dip galvanizing and the criteria for sampling and inspection of such galvanized members.

1.2 This supersedes RDSO Specification No. ETI/OHE/13 (9/82) issued in September 1982 and No. ETI/OHE/13 (11/83) issued provisionally in November, 1983.

2. PREFERENCE SPECIFICATIONS

In preparation of this specification, assistance of the following Indian Standard and other specifications has been taken.

(i)	IS : 4759-1979	:	Specification for Hot Dip Zinc Coatings on Structural Steel and other allied Products.
(ii)	IS : 209-1979	:	Specification for zinc.
(iii)	IS : 2629-1966	:	Recommended Practice for Hot Dip Galvanizing of Iron and Steel.
(iv)	IS : 6158-1971	:	Recommended Practice for Safe-guarding against Embrittlement of Hot Dip Galvanized Iron & Steel Product.
(v)	IS : 2633-1972	:	Method of Testing Uniformity of Coating on Zinc Coated Articles.
(vi)	IS : 6745-1972	:	Method for Determination of weight of Zinc Coating on Zinc coated iron and steel articles (with amendment No. 1).
(vii)	ASTM A-123 (1978)	:	Spec. for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strips.

3. GENERAL REQUIREMENTS

3.1 QUALITY OF ZINC : Zinc conforming to at least grade Zn 99.95 specified in IS : 209-1979 shall be used for the purpose of galvanizing.

3.2 BASE METAL : The steels and castings shall be in accordance with clause 2 of IS : 6158-1971. Where steel is supplied by the fabricator, it is the responsibility of the fabricator to select suitable steel which will withstand normal galvanizing operation without embrittlement.

The edges of tightly contacting surfaces should be completely sealed by welding. The residue of coated electrodes should be removed, prior to pickling, by brushing, chipping or sand blasting.

3.3 SURFACE PREPARATION : Surface shall be cleaned and prepared as per clause 4 of IS: 2629-1966. Malleable iron castings shall be shot and grit blasted before galvanizing.

3.4 GALVANISING : The members shall be galvanized in accordance with the practice contained in the IS : 2629-1966 unless otherwise specified in the succeeding paragraphs.

4. COATING REQUIREMENTS

4.1 MASS OF ZINC COATING : Minimum average mass of zinc coating on different kinds of articles shall be as under :-

Class of Material	Environment where used	Minimum average weight of zinc coating (g/m^2)
Rolled steel masts, angles, channels and members fabricated therefrom, steel forgings.	Suburban and lightly polluted area.	610
-do-	Marine and chemically polluted areas.	1,000
Malleable iron castings.	Suburban and lightly polluted area.	610
-do-	Marine and chemically polluted areas.	1,000
Structural tubes	all	610

Note : Articles galvanized with 1000 g/m^2 zinc coatings shall be identified by a band of green paint by the galvaniser.

4.2 FREEDOM FROM DEFECTS : The zinc coatings shall be uniform, adherent, reasonably smooth and free from imperfections such as flux ash and dross inclusions, bare patches, black spots, pimples, lumpiness and runs, rust stains, bulky white deposits and blisters, etc. These terms have been defined in IS : 2629-1966 which (duly amended wherever necessary) are given at Appendix 'A'.

4.3 STEEL EMBRITTLEMENT : The design of the product and the selection of steel, wherever steel is to be supplied by fabricator, for its suitability to withstand normal galvanizing operations without embrittlement or the method of fabrication shall be the responsibility of the fabricator. Recommended precautions to properly design, fabricate and prepare the material for galvanizing to prevent embrittlement shall be as per IS : 6158-1971.

5. TESTS.

5.1 TYPE TESTS

(a) Visual Inspection (Clause 7.1)
(b) Adhesion of coating (Clause 7.2)
(c) Uniformity of coating (Clause 7.3)
(d) Mass of zinc coating (Clause 7.4)

Each test shall be conducted on three samples.

5.2 ACCEPTANCE TESTS

(a) Visual Inspection (Clause 7.1)
(b) Adhesion of coating (Clause 7.2)
(c) Uniformity of coating (Clause 7.3)
(d) Mass of zinc coating (Clause 7.4)

5.3 ROUTINE TESTS

(a) Visual Inspection (Clause 7.1)

6. SCALE OF SAMPLING AND CRITERIA FOR CONFORMITY.

6.1 LOT : All the materials of the same type and the same steel, whose coating characteristics are intended to be uniform, shall be grouped together to constitute a lot. A lot shall not consist of more than one shift's production or 100 nos. whichever is lower.

Samples shall be taken from each bath for test. Where the galvanizing is done without the presence of Purchaser, the manufacturer may prepare lots consisting of the articles of the same type and material and galvanized in the same bath. If there are more than one bath, separate lots shall be prepared for each bath.

6.2 SCALE OF SAMPLING : Samples in accordance with TABLE 1 shall be taken, at random, from each lot for tests.

TABLE 1
Scale of Sampling.

Lot size	Sample size	Permissible no. of defective Units
Up to 25	3	0
26 – 50	5	0
51 – 100	8	0

6.2.1 For materials of inconvenient lengths such as OHE masts and from which it is not possible to cut a specimen for coating characteristic tests, two test pieces of same cross section and not less than 90 cms length shall be galvanized in the same bath along with the masts for each lot upto 100 masts. In such case, the visual test shall be conducted on the main piece and the tests for the adhesion, uniformity and thickness of coating shall be conducted on the test piece.

6.3 The samples selected in accordance with Table 1 above shall be subjected to the visual inspection (clause 7.1).

If any sample fails to conform to the requirement, the lot shall be rejected. The galvaniser, however, may segregate the good pieces of the lot and submit them once again for inspection.

6.4 If the lot inspected for visual inspection, passes the test, 3 samples for coating characteristics (Clause 6.5) shall be taken from the samples, which were subjected to the visual tests. In case of masts and other long articles, these tests would be conducted on test specimen cut from 90 cm long test pieces galvanized in accordance with Clause 6.2.1.

6.5 Each of the 3 samples will be subjected to test for adhesion, uniformity, mass of zinc coating. Should any sample fail in any test, six more samples shall be taken from the lot and all the 3 tests repeated. Should any sample fail in the retest, the lot shall be rejected. If it is not possible to take six samples for the test, the lot shall be rejected.

6.6 The material in a lot which has been rejected may be stripped and re-galvanized and submitted for inspection and tests.

7. TEST METHODS

7.1 VISUAL INSPECTION : The material shall be inspected visually to observe that it is smooth, reasonably bright, continuous and free from such imperfections as flux/ash/dross inclusions, bare patches, black spots, pimples, lumpiness runs, rust stains, bulky white deposits and blisters. The stains of flux, usually white in colour, shall not be regarded as flux intrusions (See Appendix 'A').

7.2 ADHESION OF GALVANISED COATING :

7.2.1 Coating shall withstand the knife tests as prescribed in IS : 2629-1966. When cut or pried into, such as with a stout knife applied with considerable pressure, in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating; and it shall not be possible to peel any portion of the coating so as to expose iron or steel underneath.

7.2.2 On articles fabricated from angles, channels, beams and rolled sections of 8 mm or more thickness, the adhesion may, alternatively, be tested by pivoted hammer tests as per IS : 2629-1966. This test is not suitable for curved and round surfaces.

7.3 UNIFORMITY OF GALVANISED COATING :

7.3.1 On small articles, which can be conveniently handled the uniformity of the coating shall be determined by Preece Test in accordance with IS : 2633-1966 by dipping the whole article in the copper sulphate solution. For sheets, strips and other fabricated articles a 10 cm x 10 cm specimen may be cut for tests. For tubes, 100 mm long piece shall be cut from each end of the product, after discarding 300 mm length from the end. The article shall withstand 5 dips of one minute each.

7.3.2 For long articles, such as masts, etc., measurement of coating thickness at a number of places by magnetic method (Clause 7.4.4) shall be taken as a uniformity test.

Note : The Preece Test is primarily meant for articles where surface is mechanically scrapped or wiped after dip in the galvanizing baths, such as tubes, wires, etc.

7.4 MASS OF GALVANISED COATING :

7.4.1 The average mass of galvanized coating shall be determined by any one of the following methods as agreed between the purchaser and the galvaniser before the tests.

7.4.2 **Mass before and after galvanizing** : The mass of coating may be determined by weighing the article before and after galvanizing, subtracting the first mass from the second and dividing the result by the coated surface area. The first mass shall be

determined after pickling, rinsing and drying; and the second after cooling to the ambient temperature.

7.4.3 **Stripping method** : In case of materials galvanized without purchasers' inspection, average mass of coating shall be determined by stripping the entire article in accordance with IS : 6745-1972 (See Appendix 'B'). If the surface area of the entire article cannot be measured easily or if the article is inconveniently large, a specimen of 100 sq. cm. area may be cut from each of the three samples (90 cm long test-piece in case of masts) and stripped.

7.4.4 **Magnetic thickness gauge method** :

7.4.4.1 For large products such as poles, towers, structural shapes and castings the average weight of the coating shall be determined by a magnetic thickness gauge.

7.4.4.2 Before making the measurement the gauge shall be calibrated by measuring the thickness of zinc coating on a test panel and comparing the measured value with the value obtained by stripping method on the same piece.

7.4.4.3 In case of masts etc. readings shall be taken along the length at 100 mm interval and in approximate centre of the flange and then averaged to give a single figure for thickness of coating. For castings etc. at least 5 readings may be taken at convenient locations nearly in the centre. Thickness, in micro-meters, when multiplied by 7.047 would give the average mass of zinc coating (g/m^2). Three articles in each lot of upto 100 shall be tested in this manner. Thickness shall not be less than the minimum value specified in Clause 4.1.

8. RECTIFICATION OF DAMAGE

8.1 Normally all fabrication work in the case of galvanized articles shall be completed prior to galvanizing. If, for any reason, fabrication such as cutting, drilling or welding has to be undertaken after galvanizing, protection of metal exposed as a result of fabrication and rectification of damaged galvanized areas shall be done in accordance with either the following methods or any other method approved by the Purchaser.

8.2 USE OF ZINC BASED SOLDERS : The surface to be protected, or the surface where galvanizing has been damaged, shall be cleaned and any oxides removed with a weak acid solution and a wire brush. The surface shall be thoroughly washed with water to make it free from any traces of acid. The cleaned area shall be heated with a welding torch and rubbed with white salammoniac. A piece of zinc stick or rod 5-10 mm diameter of high purity shall be melted on this area and spread out with a heated piece of salammoniac. The areas shall then be washed down by water and lightly wire brushed. The workmanship shall be such that the finished surface is smooth and non-porous.

8.3 USE OF ZINC RICH PAINTS : The damaged surface after cleaning, as mentioned in para 7.2 shall be painted with two or more coats of zinc rich primer followed by a finishing coat of a zinc rich paint as per the painting schedule recommended by the manufacturers. It is to be ensured that the dry film thickness of zinc rich primer shall not be less than the average thickness of the galvanized coating. The complete painting system i.e. zinc rich primer with the finishing zinc rich paint for this purpose shall be produced from a source of repute and approved by the Purchaser.

APPENDIX "A" (Cl. 4.2)

DEFECTS, THEIR CAUSES AND REMEDIAL MEASURES

Defects	Causes	Recommended actions	Ground for rejection
	Paint grease or oil residues	Check cleaning practices	
Bare spots	Scale or rust residues	Check pickling practices	Yes, if bare spots are bigger than 8 mm dia. or 8 mm diagonal.
	Residual welding slag	Blast-clean wells; avoid coated rods	
	Breakdown of preflux coating	Check preflux and drying conditions	
	Aluminium content of bath too high	Regulate aluminium additions	
	Rolling defects in basic steel	Check steel supply	
	Article in contact during galvanizing.	Keep articles separated.	
General roughness	Analysis or original surface condition of steel.	Check steel supply.	
	Over-pickling	Reduce pickling use inhibitor	No
	High galvanizing temperature or long immersion time or both	Adjust galvanizing conditions.	
Pimples	Entrapped dross particles	Avoid agitation of dross layer; check carry over of pickle salt.	No, unless dross contamination is heavy
Lumpiness and runs (uneven drainage)	Withdrawal speed too high	Remove work slowly	No.
	Cold galvanizing bath.	Increase temperature.	
	Delayed run-off from seams, joints, bolt holes, etc.	Remove work slowly.	
	Article in contact during withdrawal.		
Flux inclusions	Stale flux burnt on during dipping.	Refresh or renew flux blanket.	Yes.
	Surface residues on steel.	Check steel preparation.	
	Flux picked up from top of bath.	Skim before withdrawal.	
Ash inclusion	Ash burnt on during dipping.	Skim bath before dipping.	Yes, if in gross lumps.
	Ash picked up from top of bath.	Skim before withdrawal.	

Black spots	Includes flux particles from flux 'dusting'.	Confine fluxing to top of bath.	Yes.
	Dirt smuts, splash marks.	Check storage conditions.	No.
Dull grey coating (all alloy, no free zinc).	Steel composition (high silicon, phosphorous or carbon) severe cold work.	Check steel supply for composition order to adjust for galvanizing.	No.
	Slow cooling after galvanising.	Avoid hot stacking quench.	
	Release of absorbed hydrogen during solidification of coating.	Avoid over pickling; use inhibitor.	
	Weeping of acid etc. from seams and folds.	Check product design and fabrication.	
Rust stains	Storage near rusty material.	Check storage condition.	No.
Bulky white deposit (wet storage stain, white rust).	Confinement of close packed articles under damp conditions.	Storage dry well-ventilated conditions, separate articles with spacer.	No.
	Packing of articles while damp.	Dry before packing; include desic cant.	
Blisters	Expansion of entrapped hydrogen and moisture in flaws.	Check steel quality	Yes, if general.
	Driving off of hydrogen absorbed during pickling.	Use shot blast instead of pickle; check steel supply.	
	Improper malleabilising (for malleable iron castings only)	Check malleabilising practice.	
Tiny blisters	Effect sometimes observed on quenched work notably malleable castings. May be caused by gas evolved from the work resulting from absorbed hydrogen or break-down of combined carbon near surface.	Use shot blast instead of pickle. Check malleabilising treatment. Should have no combined carbon near surface of casting.	Yes, if blistering is generally wide spread.

APPENDIX "B"

STRIPPING METHOD

(Extracted from IS : 6745-1972)

Cleaning of test piece : The test pieces shall be washed with solvent naptha, trichloro ethylene or any other suitable organic solvent, then with alcohol and finally dried thoroughly.

Stripping Solutions :

Dissolve 20 g of antimony trioxide (Sb_2O_3) or 32 g of antimony trichloride ($Sb\ Cl_3$) in 1000 ml of concentrated hydrochloric acid (specific gravity 1.1).

Immediately before tests, prepare the stripping solution by adding 5 ml of the solution prepared under clause B-2.1 to 100 ml of concentrated hydrochloric acid (specific gravity 1.16). Mix well.

Procedure – Weigh the cleaned test specimen whose mass is less than 200 g nearest to 0.01 g; for test piece whose mass is between 300 to 1000 g to the nearest 0.1 g; and for test specimen of over 1000 g to the nearest 0.5 g. After weighing immerse each test piece singly in test solution prepared as per clause B-2.2 and allow to remain there until the violent evolution of hydrogen and only a few bubbles are being evolved. This requires about 15 to 30 seconds.

The mass of zinc coating (in g/m^2) of surface may be calculated as per the following formula :

$$M = \frac{M1 - M2}{A} \times 10^6$$

Where,

M = mass of zinc coating, in g/m^2, of surface.
M1 = original mass, in g, of test piece.
M2 = mass in g, of stripped test piece, and
A = coated area of the test piece, in mm^2.

Correction Slip No. 1 (May 1986) to RDSO Specification No. ETI/OHE/13 (4/84)
for
Hot Dip Zinc Galvanization of Steel Mast, (Rolled & Fabricated)
Tubes & Fittings used on 25 kV AC OHE.

1. Clause 6.1 shall be revised as under :

6.1 LOT : All the material of the same type in a coating bath whose characteristics are intended to be uniform shall be grouped together to constitute a lot.

6.1.1 Sample shall be taken from each bath and tested for conformity of coating.

2. Table 1 under clause 6.2 shall be revised as under :

TABLE 1

Scale of Sampling.

Lot size	Sample size	Permissible no. of defective Units
Up to 25	3	0
26 – 50	5	0
51 – 100	8	0
101 and above.	13	1

Corrigendum Slip No. 2 (4/90) to RDSO Specification No. ETI/OHE/13 (4/84)
for
Hot Dip Zinc Galvanization of Steel Mast, (Rolled & Fabricated)
Tubes & Fittings used on 25 kV AC OHE.

1. Appendix B

1.1 Clause B-1, 1st line, Read
'trichloro ethylene' in place of 'trichloro ethylen'.

1.2 Clause B-2, Read 'Stripping Solution' in place of 'Stripping solutions'.

1.3 Clause B-2.1, Read 'Hydrochloric Acid (Specific Gravity 1.16)' in place of 'Hydrochloric Acid (Specific Acid 1.12)'.

1.4 Clause B-3, Line No. 3, Read 'Clause B-2.1' in place of 'Clause B-2.2'.

1.5 Clause B-3, Insert the word 'ceases' in last line of the clause between 'hydrogen and 'and'.

Research Designs & Standards Organisation
(Traction Installation Directorate)

Note

Note No. TI/CIV/GCP/18
Dated: 26.03.2018

S.N.	Contents of uploaded Specification	Comments received from the firms	RDSO (TI) Remarks
A.	Specification no. ETI/OHE/13 (4/84) on RDSO website on 30.01.2018	CORE/Allahabad as well as CORE's vendors.	
1.	The structural tubes coating size is proposed as 610 gm/m^2 and 800 gm/m^2 for lightly polluted area and heavily polluted area respectively in place of presently specified as 425 gm/m^2 through A&C slip No. 4/(4/90) to above specified Specification.	Nil.	Nil.

APPENDIX 'B'

STRIPPING METHOD

(Extracted from IS: 6745-1972.)

B-1 Cleaning of Test Piece : The test pieces shall be washed with solvent naptha, trichloro ethylen or any other suitable organic solvent, then with alchohol and finally dried thoroughly

B-2 Stripping Solutions :

B-2.1 Dissolve 20 g of antimony trioxide (Sb_2O_3) or 32 g of antimony trichloride ($Sb\ Cl_3$) in 1000 ml of concentrated hydrochloric acid (specific gravity 1.1$_2$).

B-2.2 Immediately before tests, prepare the stripping solution by adding 5 ml of the solution prepared under clause B-2.1 to 100 ml of concentrated hydrochloric acid (specific gravity 1.16). Mix well.

B-3 Procedure.—Weigh the cleaned test specimen whose mass is less than 200 g nearest to 0.01 g; for test piece whose mass is between 300 to 1000 g to the nearest 0.1 g; and for test-specimen of over 1000 g to the nearest 0.5 g. After weighing immerse each test piece singly in test solution prepared as per clause B 2.2 and allow to remain there until the violent evolution of hydrogen and only a few bubbles are being evolved. This requires about 15 to 30 seconds.

B-4 The mass of zinc coating (in g/m²) of surface may be calculated as per the following formula:

$$M = \frac{M1 - M2}{A} \times 10^6$$

Where,
M = mass of zinc coating, in g/m², of surface.
M1 = original mass, in g, of test piece.
M2 = mass in g, of stripped test piece, and
A = coated area of the test piece, in mm².

Addendum / Corrigendum Slip No. 3 (4/90) to RDSO
Specification No. ETI/OHE/13 (4/84)
for
Hot Dip Zinc Galvanization of Steel Mast, (Rolled & Fabricated)
Tubes & Fittings used on 25 kV AC OHE.

1. Clause 2

Add new item as SN (viii) below the para.

viii)	ASTM : A 153 (1982)	-	Specification of zinc coating (Hot-dip) on Iron and Steel hardware.

2. Clause 2

SN (i) Read "IS : 4759 – 1984" in place of "IS : 4759 – 1979".

3. Clause 4.1, Delete last line "(Structural ---------- 610) and add the following in the respective columns :

Steel Components less than 5 mm thick	all	460
Structural Tubes	all	425".

16-6-86

May 1986

REFERENCE COPY

Correction Slip No.1 to RDSO Specification No.ETI/OHE/13(4/84)

for

Hot Dip Zinc Galvanisation of Steel Masts (Rolled & Fabricated), Tubes & Fittings used on 25 kV a.c. OHE

1. Clause 6.1 Shall be revised as under:

6.1 LOT: All the material of the same type in a coating bath whose characteristics are intended to be uniform shall be grouped together to constitute a lot.

6.1.1 Sample shall be taken from each bath and tested for confirmity of coating.

2. Table 1 under clause 6.2 shall be revised as under:

TABLE - 1.
Scale of Sampling

Lot size	Sample size	Permissible no. of Defective units
Upto 25	3	0
25-50	6	0
51-100	8	0
101 and above.	13	1

(6/90)

Correction Slip No. 2 to RDSO specification No. TI/OHE/713(4/84).

for

Hot Dip Zinc Galvanisation of Steel Masts (Rolled & Fabricated), Tubes & Fittings used on 25 kV a.c. OHE

1. Appendix B

1.1 Clause B-1, 1st line, Read 'trichloro ethylene' in place of 'trichloro ethylen'

1.2 Clause B-2, Read 'Stripping solution' in place of 'Stripping Solutions'

1.3 Clause B-2.1, Read 'Hydrochloric Acid (Specific Gravity 1.16)' in place of 'Hydrochloric Acid (Specific Gravity 1.12)'

1.4 Clause B-3, Line No. 3, Read 'Clause B-2.1' in place of 'Clause B-2.2'.

1.5 Clause B-3, Insert the word 'ceases' in last line of the clause between 'hydrogen' and 'and'.

Specification No. ETI/OHE/13(4/84)
For
Hot Dip Zinc Galvanisation of Steel Masts(Rolled & Fabricated),Tubes & Fittings used on 25kV ac OHE

1. Clause 2.

Add new item as SN. VIII below the para

VIII) ASTM: A 153 (1982) - Specification for Zinc coating (Hot-dip) on Iron and Steel hardware.

2. Clause 2.

SN(1) Read'IS: 4759-1984' in place of " IS: 4759-1979".

3. Clause 4.1, Delete last line'(Structural----610) and add the following in the respective columns:

Steel Components less than 5mm thick	all	460
Structural Tubes	all	425

Addendum & corrigendum slip No. 4 to RDSO.

Specification No. ETI/OHE/13(4/84)
For
Hot dip zinc galvanisation of Steel Masts (Rolled & Fabricated), Tubes & fittings used on 25 kv ac OHE

1. A & C slip No.3(4/90)- Para3 delete last line (Structural tubes - all - 425) and the following is added in the respective column.

Structural tubes:	
Lightly polluted area	610
Medium and heavy polluted area	800