

SPECIFICATION No. ETI/OHE/11(5/89)

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW 226 011**

**25 kV a.c. TRACTION OVERHEAD EQUIPMENT
SPECIFICATION
FOR
STEEL TUBES**

1. **SCOPE:** This specification covers the requirement for galvanised structural steel tubes for 25 kV ac traction overhead equipment and supersedes specification no. ETI/OHE/11/ (5/89).
2. **SERVICE CONDITION:**
- 2.1 The tubes are used as members of cantilever assemblies supporting the traction overhead conductors and are subjected to tensile, bending and compressive stresses, due to axial force and bending moment.

Maximum temperature of air in the shade	45 degree C
Minimum temperature of air in the shade	0 degree C
Maximum temperature attainable by an Object exposed to sun	65.5 degree C
Maximum relative humidity	100%
Average annual rain- fall	1750 to 6250 mm
Number of thunder storm days per annum.	85 days Max.
Average number of dust storm day per annum	35 days Max.
Number of rainy days per annum	120 days Max.
Maximum wind pressure	200 kg/sq. m.
Altitude	Not exceeding 1000 m

- 2.3 In certain areas, the tubes are also subjected to chemical pollution form the effluent gases of chemical/fertiliser plants and exhaust gases of steam/diesel locomotives and to saline atmosphere near the sea.

3. **GOVERNING SPECIFICATIONS:**

- 3.1 The tubes shall conform to IS: 3601: specification for steel tubes for mechanical and general engineering purposes.
- 3.2 The provisions of governing specifications shall be applied in the manner altered/amended or supplemented by this specification.
- 3.3 In preparation of this specification reference has been made to the following specification:

(i)	IS:3601-2006	Steel tubes for mechanical and general engineering purposes.
(ii)	IS:1161-1998	Steel tubes for structural purposes.
(iii)	ETI/OHE/13 (4/84) with latest correction slips	Specification for Hot dip zinc galvanisation of steel mast (rolled) and fabricated), tubes & fittings used on 25 kV ac OHE.
(iv)	IS:4736-1986	Hot dip zinc coatings on steel tubes.
(v)	IS:6012-1992	Method for measurement of coating thickness by eddy current.
(vi)	IS:3203-1982	Methods for testing local thickness of electroplated coatings.
(vii)	IS:228(Pt.3)-1987	Determination of phosphorus by alkalimetric method.
(viii)	IS:228(Pt.9)-1989	Determination of sulphur in plain carbon steel by evolution method.

(ix)	IS:1894-1972	Method for tensile testing of steel tubes.
(x)	IS:2328-2005	Method for flattening test on metallic tubes.
(xi)	IS:2335-2005	Method for drift expanding test on metallic tubes
(xii)	IS:2329-2005	Method for bend test on metallic tubes.
(xiii)	IS:4711-2011	Methods for sampling of steel pipes, tubes and fittings.
(xiv)	IS:4740-1979	Code of Practice for packaging of steel tubes.

4. **DEVIATION FROM SPECIFICATON:** Any deviation from this specification calculated to improve the performance, efficiency and utility of the steel tube proposed by the tenderer, will be given due consideration provided full particulars with justification thereof are furnished.
5. **DESIGNATION, SIZES AND TYPES OF TUBES:** Designation, sizes and types of tube covered in this specification are shown in the Table-1. The tubes used for register arm and stay arm are designated as 'Small' tubes and those used for bracket arm are designated as 'Standard' and 'Large' tubes.

TABLE-1
(All sizes are in mm)

Designation	Size							Type
	Outside diameter			Thickness		Inside diameter		
	Standard	Max. *	Min.	Standard	Min. **	Standard	Min. +	
Small	33.70	34.50	32.70	2.65	2.34	28.40	27.70	Electric resistance or induction butt welded (ERW).
Standard	38.00	38.32	37.80	4.05	3.70	29.90	29.58	Cold drawn seamless (CDS) or cold drawn electric resistance welded (CEW); or electric resistance or induction butt welded (ERW)
Large	49.00	49.32	48.80	4.05	3.70	40.90	40.58	-do-

- * Maximum values at any section after galvanising.
- ** In the case of ERW tubes these are the minimum values of thickness excluding the weld.
- + Minimum values at any section after galvanising. To be checked by purchaser's representative with suitable plug gauges.

6. **TOLERANCES ON DIMENSIONS:** The tolerances on dimensions shall be specified in Table-I. The outside diameter shall not exceed the appropriate maximum value given in Table-I at any section after galvanisation. The inside diameter shall not be less than the appropriate minimum value given in Table – 1 at any section after galvanisation.
7. **MATERIAL:** The tubes shall be manufactured from steel made by any approved process such that when analysed in accordance with the methods specified in IS:228(Pt.3) and IS:228(Pt.9) steel shall not contain more than 0.06 percent sulphur and not more than 0.06 percent phosphorus.
8. **GRADE AND TYPES:** The tubes shall be of grade Yst 310 of IS: 1161. The tubes may be either ERW (Electric resistance or induction butt welded) or CDS (Cold drawn seamless) or CEW (Cold drawn electric resistance welded) type. The CDS and CEW tubes shall be supplied in as drawn condition.
9. **WORKMANSHIP:** The tubes shall be cleanly finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut cleanly and square with the axis of the tube.
10. **STRAIGHTNESS:** Unless otherwise agreed to between the purchaser and manufacturer, tubes shall not deviate from straightness by more than 1/600 of any length.

11. **LENGTHS:** The tubes shall be supplied in exact lengths specified by the purchaser in the order. The tolerances shall be subject to prior agreement between the manufacturer and the purchaser.
12. **GALVANIZING:** ETI/OHE/13 (4/84) shall be followed for Galvanisation as applicable for steel tubes.
- Note: The tubular test piece shall be of 100 mm length, out of the specimen chosen, after discarding a length of 300 mm from both ends.
tubes, if required, shall be done prior to galvanizing.
13. **INTERNAL AND EXTERNAL FIN:** The external fin shall be removed where applicable. The internal fin, if any, may be removed if the inside diameter is not less than the minimum value specified in Table –1 at any section after galvanization.
14. **MECHANICAL PROPERTIES:** The mechanical properties, after galvanization of the tubes shall be as given in Table-2.

TABLE-2
MECHANICAL PROPERTIES OF STEEL
TUBES AFTER GALVANISING

Grade	Tensile strength Mpa (Min.)	Yield strength Minimum, Mpa	Minimum Percentage Elongation on gauge length of 5.65
1	2	3	4
Yst 310	450	310	14

S_o = Original cross sectional area of the gauge length.

15. **TESTS:**

- 15.1 The manufacturer shall carry out the specified tests, during production, on the samples taken at regular intervals, to ensure conformity to relevant specifications as also to maintain proper control over the process of manufacture. The manufacturer shall maintain the frequency of the various tests at least at the levels given in (Appendix-A) of IS: 4711 at Annexure-1) and shall, at the time of inspection, produce a certificate showing the frequencies of various inspections/tests which have been exercised during production.
- 15.2 When the purchaser requires additional tests related to his order, such test shall be the subject of agreement between the purchaser and the manufacturer.
- 15.3 All the tests on the tube shall be carried out at the manufacturer's works. The manufacturer shall arrange without making claim or charge, all the necessary machinery, apparatus, labour assistance etc required to get the prescribed tests conducted in the presence of the Purchaser's representative. The tests shall be carried out after galvanizing.

15.4 **TESTS:**

TABLE-3

S.N.	Tests	Clause No.	Type Tests	Routine Tests	Acceptance Tests
(i)	Visual Examination	16.1	Yes	Yes	Yes
(ii)	Measurement of dimensions:		Yes	NO	Yes
	(a) Outside diameter	16.2.1	Yes	NO	Yes
	(b) Inside diameter	16.2.1	Yes	NO	Yes
	(c) Thickness	16.2.2	Yes	NO	Yes
	(d) Diameter at internal fin	16.2.3	Yes	NO	Yes
(iii)	Tensile test	16.3	Yes	NO	Yes
(iv)	Flattening test (For ERW & CDS tubes only)	16.4	Yes	NO	Yes
(v)	Drift expanding test (For ERW tubes only)	16.5	Yes	NO	Yes
(vi)	Cold bend test (For ERW CDS tubes only)	16.6	Yes	NO	Yes

(vii)	Crushing test (For CDS & CEW tubes only)	16.7	Yes	NO	Yes
(viii)	Galvanizing test	16.8	Yes	NO	Yes
(ix)	Chemical composition of steel	16.9	Yes	NO	Yes

Each test shall be conducted on three samples.

15.5 SAMPING AND INSPECTION PROCEDURE AND CRITERIA FOR ACCEPTANCES:-

15.5.1 Tubes shall be offered for inspection in lots. One lot shall contain the tubes of only one designation, type, size and length,

15.5.2 The samples shall be selected at random and examined for each lot separately after it has passed the routine test for ascertaining their conformity to the requirements of this specification.

15.5.3 The lot which has been found satisfactory in visual examination shall be tested for dimensional characteristics like lengths, diameter and thickness.

15.5.4 The samples for dimensional test shall be taken from the lot in accordance with table-4.

TABLE-4
SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES FOR DIMENSIONAL CHARACTERISTICS.

Lot size	Sample size	Acceptance number
Upto 100	3	0
1001 to 150	5	0
151 to 300	8	0
301 to 500	13	1
501 to 1000	20	2
1001 to 3000	32	3
3001 to 10000	50	4
10001 and above	80	5

15.5.5 Each of the items selected according to 15.7.4 shall be inspected for all dimensional requirements. Any items failing to meet one or more dimensional requirements shall be considered as defective. If the number of defective ones found in the sample checked for dimensional characteristics is less than or equal to the corresponding acceptance number, the lot shall be deemed as having met the dimensional requirements of this specification, otherwise not.

15.5.6 In case of those lots which have been found unsatisfactory, all the samples in the lot may be inspected for dimensional characteristics and the defective ones be removed, if agreed by the purchaser.

15.6 The lot shall then be tested for physical properties like tensile strength, cold bend, flattening, drift expanding and crushing tests, chemical composition and galvanisation. The samples, in accordance with Table-5, may be taken at random from those already drawn for dimensional inspection.

15.6.1 From each of the items so chosen, the required number of test specimens shall be prepared for conducting the tests specified in Table-3-acceptance test. The manner of preparation of tests specimens as well as their dimensions shall be in accordance with this specification. Any item failing to meet the requirement of tests shall be considered as a defective.

TABLE-5

SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVE FOR PHYSICAL AND CHEMICAL TESTS (TENSILE, BEND, FLATTENING, DRIFT, CRUSHING AND GALVANIZING TESTS).

(Clause 15.6)

Lot size	Stage of sample	Sample size for each test	Acceptance number (a)	Rejection number (r)
Upto 300	First	3	0	1
	Second	3	0	1
301 to 800	First	5	0	2
	Second	5	1	2
801 to 3000	First	8	0	2
	Second	8	2	3
3001 and above	First	13	1	3
	Second	13	3	4

15.6.2 CRITERIA FOR ACCEPTANCE: For any of the tests, if in the first stage of sample the number of defective samples is less than or equal to corresponding acceptance number (a), the lot shall be declared as conforming to the requirement of that test. If the number of defectives is greater than or equal to the corresponding rejection number (r), the lot shall be deemed as not meeting the requirement of this specification. If the number of defectives is greater than the acceptance number but less than the rejection number, a second stage of sample of the same size as the first shall be taken to determine the conformity or otherwise of the lot. The number of defective ones found in first and second stage of samples shall be combined and if the combined number of defective ones is less than or equal to the corresponding acceptance number of the second stage of sample, the lot shall be declared as conforming to the requirements of the particular test, otherwise not.

16. METHODS OF TESTS:

16.1 VISUAL EXAMINATION:- Tubes shall be visually examined for clean finish, cracks, surface flaws, welds, straightness and for galvanizing. The zinc coating on the tube 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. Care shall be taken to see that marking on tube has been done before galvanizing.

16.2 MEASUREMENT OF DIMENSIONS:-

16.2.1 OUTSIDE AND INSIDE DIAMETER:- Outside and inside diameter of the tube shall be measured at 3-4 places with the help of calliper. The measurements shall be made in two perpendicular directions situated approximately in the same cross section. The diameter shall be within limits specified in Table-1. The manufacturer shall provide necessary gauges if dimensional measurement is to be done on all the items of a lot (Clause 15.5.6).

16.2.2 THICKNESS: The thickness of tube shall be measured with the help of calliper at 3 places in different planes. The thickness, after deducting 0.2mm for zinc coating, shall be within limits specified in Table-1.

16.2.3 DIAMETER IN INTERNAL FIN: Inside diameter of the tube at internal fin shall be measured with the help of calliper. In no case the diameter at internal fin shall be less than the minimum inside diameter of the tube as specified in Table-1.

16.3 TENSILE TEST: The tensile strength, the yield stress and the percentage elongation shall be determined in accordance with methods specified in IS:1894 and shall not be less than the values specified in Table-2. Tensile test shall be conducted after galvanizing.

16.4 FLATTENING TEST: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattened between parallel plates with the weld, if any, at degree in accordance with

IS:2328. No opening shall occur by fracture in the weld until the distance between the plates is less than 75 percent of the original outside diameter and no cracks or break in the metal elsewhere than in the weld shall occur until the distance between the plates is less than $8t$ or $7/8$ times the inside diameter whichever is smaller where 't' is the thickness of tube.

16.5 DRIFT EXPANDING TEST: This test shall be carried out in accordance with IS: 2335. The length of the test depends on the angle of the cone of the drift expansion mandrel. When the angle is equal to or less than 30, the length of test pieces shall be equal to $4\sqrt{r}$ -----

16.6 COLD BEND TEST:

16.6.1 On ERW tubes: This test shall be conducted in accordance with IS: 2329. The unfilled test piece of tube shall be bent cold, with the weld at 90 degree to the place of bending, by means of a tube bending machine through 90 degree, round a grooved former having at the bottom of the groove the radius equal to 8 times the diameter of the tube. The tube shall not show any sign of crack or flaw as a result of this test.

16.6.2 On CDS tubes: A strip not less than 38 mm wide, cut circumferentially from one end of the tube shall, when cold, be doubled over in the direction of original curvature, round a bar of the diameter equal to '5t' where 't' is the thickness of the tube. The strip shall not show either crack or flaw. Slight premature failures at the edges of a specimen shall not be considered a cause for rejection.

16.7 CRUSHING TEST: A piece of tube approximately equal in length to 1.5 times the outside diameter, cut from one end, with the ends parallel and square with its axis, shall be crushed cold lengthwise, until its length is reduced by not less than the perching of the original length specified in the appropriate section As per IS: 3601-89 Cl. 12.5. The tube shall show no sign of crack or flaw as a result of this test.

16.8 GALVANIZING TEST:

16.8.1 The galvanising of the tube when tested shall meet the requirements of clause - 5.1, 5.4 and 5.5 of IS: 4736. The weight of zinc coating when tested shall not be less than as specified in ETI/OHE/13(4/84) applicable for steel tubes. The thickness of zinc coating shall be measured separately on both inside as well as outside surfaces of the tube.

16.8.2 In order to measure the thickness of the tube, magnetic or microscopic method as per IS: 3203 or eddy current method as per IS: 6012 may be employed by the inspector separately for inside and outside of tube. The surface density of coating in gram/sq. m. may be calculated by multiplying the thickness of coating in mm by a factor 7047.

16.9 CHEMICAL COMPOSITION OF STEEL: The material of the tube when analysed in accordance with the methods specified in IS: 228 (Pt. 3) and IS: 228 (Pt. 9) and relevant parts thereof shall not contain more than 0.06 percent phosphorus.

17. BUNDLING AND PACKING: The tubes shall be bundled and packed in accordance with IS: 4740.

18. MARKING:

18.1 A plastic tag or metal plate shall be fixed at least at both the ends of the bundle, giving the following particulars:

- (i) Size, designation, type and grade;
- (ii) Number of tubes packed;
- (iii) Length of each piece;
- (iv) Net and gross weight;
- (v) Manufacturer's trade name, brand or mark;
- (vi) Contract number/purchase order number and consignee;
- (vii) Date of inspection and inspecting authority;
- (viii) Any other particulars specified by the Purchaser.

ENCLOSURE: Annexure – I

ANNEXURE-1 TO Specification No. ETI/OHE/11(5/89)
RECOMMENDED LEVELS OF INSPECTION/TESTING

S.N.	Characteristics for inspection/ testing	Frequencies of Inspection/Testing for pipes and tubes manufactured by:	
		Seamless process	Other process like Fretz-Monn and ERW.
1.	Chemical composition	A ladle analysis from every tube.	A laddle analysis from every cast.
2.	Visual inspection for surface defects and steel defects.	Each pipe and tube.	Each pipe and tube.
3.	Outside diameter.	All pipes and tubes.	One per hour
4.	Thickness	All pipes and tubes.	One per hour
5.	Length	All pipes and tubes	One per hour
6.	Tensile test	One coil on each cast.	One coil from each cast.
7.	Bend test	One for every 100 or part thereof.	One every half an hour.
8.	Flattening test	One for every 20 or part thereof.	One every half an hour.
9.	Drift test	One for every 20 or part thereof.	One every half an hour.