Maharashtra State Electricity Distribution Company Limited

SPECIFICATION NO. T&QC: MSC-I / AAA conductor /2019/04/01

TECHNICAL SPECIFICATION

FOR

ALUMINIUM ALLOY STRANDED CONDUCTORS FOR OVERHEAD TRANSMISSION

FOR

DISTRIBUTION SYSTEM

IN

MSEDCL

ALUMINIUM ALLOY STRANDED CONDUCTORS FOR OVERHEAD TRANSMISSION

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I N D E X

MAHARASHTRA STATE ELECTRICITY DISTRIBUTION COMPANY
Technical Specifications for

ALUMINIUM ALLOY STRANDED CONDUCTORS FOR OVERHEAD TRANSMISSION

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1. SCOPE:

This specification covers the design, manufacture, testing at works and supply of ALUMINIUM ALLOY STRANDED CONDUCTORS FOR OVERHEAD TRANSMISSION used in the MSEDCL distribution network A.C. 3 phase, 3 wires, 33/22/11 kV, 50 HZ as per IS : 398 (Part IV) 1994 amended upto date , IS : 1778 before dispatch, packing and delivery FOR destination. All Size of conductor shall be supplied with **ISI** mark only.

2. SERVICE CONDITIONS:

The AAA conductor to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

2.1	Maximum ambient temperature (Degree C)	50
2.2	Maximum temperature in shade (Degree C)	45
2.3	Minimum Temperature (Degree C)	3.5
2.4	Relative Humidity (percent)	10 to 95
2.5	Maximum Annual rain fall (mm)	1450
2.6	Maximum wind pressure (kg/sq.m)	150
2.7	Maximum altitude above mean sea level (Meter)	1000
2.8	Isoceranic level (days per year)	50
2.9	Seismic level (Horizontal Acceleration)	0.3 g

Moderately hot and humid tropical climate conductive to rust and fungus growth ….

3. SYSTEM DETAILS:

AAA conductor are meant for erection of 33,22, 11kV lines with relevant parameters as under:-

Sr. No..	Particulars	Details		
1.	System Voltage	33 KV	22 KV	11KV
2.	Maximum Voltage	36	24	12
3.	Frequency	50 Hz	50 Hz	50 Hz
4.	Lightning impulse withstand voltage (Dry and Wet)	70/170 (peak)	50/125 (peak)	28/75 (peak)
5.	Power frequency withstand voltage (Wet)	70	50	28
6.	Short circuit level in 3 sec .kA	25	25	25

4 APPLICABLE STANDARDS:

Sr. No.	Indian Standard	Title
1	IS : 398 (Part IV) / 1994	Specifications of Aluminium conductors for overhead transmission purpose
2.	IS 1885 (part 32) 1971	Electrotechnical vocabulary: part 32 Cabels , conductors and accessories for electricity supply
3	IS : 1778	Reels and Drums for bare conductors
4	IS : 1841	E.C. Grade Aluminium Rod produced by rolling
5.	IS : 5484	E.C.Grade Aluminium rod produced by continuous casting and rolling
6.	IS:9997 :1981	Aluminium alloy redraw rods for electrical purposes (first revision)

5. GENERAL TECHNICAL REQUIREMENT:

AAA conductor shall be suitable for being installed directly in air supported on Pin insulator or suspension disc insulator string or anchored through tension disc insulator strings of single circuit or double circuit high voltage lines.

6. PRINCIPAL PARAMETERS OF CONDUCTOR :

The properties of stranded all aluminum alloy conductors of various sizes shall be as in Table – 1

Table-1

Sr.no	Actual Area (mm^2)	Name of conductor (mm)	Stranding and Wire Dia (mm)	Approx. overall Diameter (mm)	Approx. mass (Kg/Km)	Calculated maximum resistance at 20°C (Ohms/Km)	Approx. Calculated Breaking Load	Final Modulus elasticity (Kg/Sq.cm)	Coefficient of linear expansion ($/^0C$)
1	15	Mole	3/2.50	5.39	40.15	2.3040	4.33	$0.6500x10^6$	$23x10^{-6}$
2	22	Squirrel	7/2.00	6.00	60.16	1.5410	6.45	$0.6324x10^6$	$23x10^{-6}$
3	34	Weasel	7/2.50	7.50	94.00	0.9900	10.11	$0.6324x10^6$	$23x10^{-6}$
4	55	Rabbit	7/3.15	9.45	149.20	0.6210	16.03	$0.6324x10^6$	$23x10^{-6}$
5	80	Racoon	7/3.81	11.43	218.26	0.4250	23.41	$0.6324x10^6$	$23x10^{-6}$
6	100	Dog	7/4.26	12.78	272.86	0.3390	29.26	$0.6324x10^6$	$23x10^{-6}$
7	125	Dog (up)	19/2.89	14.45	342.51	0.2735	36.64	$0.612x10^6$	$23x10^{-6}$
8	148	Coyote	19/3.15	15.75	406.91	0.2298	43.50	$0.612x10^6$	$23x10^{-6}$
9	173	Wolf	19/3.40	17.00	474.02	0.1969	50.54	$0.612x10^6$	$23x10^{-6}$
10	200	Wolf(up)	19/3.66	18.30	549.40	0.1710	58.66	$0.612x10^6$	$23x10^{-6}$
11	232	Panther	19/3.94	19.70	636.67	0.1471	68.05	$0.612x10^6$	$23x10^{-6}$

7. A. PROPERTIES OF WIRES :

The properties of Aluminum Alloy wires used to construct stranded Aluminum Alloy conductors must be as follows:

Sr. no	Nominal Diameter (mm)	Actual Diameter(mm)		Cross sectional area of Nominal Diameter wire (mm^2)	Mass (Kg/Km)	Minimum Breaking Load (kN)		Maximum resistance at 20°C (Ohms/Km)
		Min	Max			Before Stranding	After Stranding	
1	2	1.98	2.02	3.142	8.482	0.97	0.92	10.653
2	2.5	2.47	2.53	4.909	13.25	1.52	1.44	6.845
3	2.89	2.86	2.92	6.56	17.71	2.03	1.93	5.106
4	3.15	3.12	3.18	7.793	21.04	2.41	2.29	4.290
5	3.31	3.28	3.36	8.605	23.23	2.66	2.53	3.882
6	3.40	3.37	3.43	9.079	24.51	2.80	2.66	3.677
7	3.45	3.42	3.48	9.348	25.24	2.89	2.75	3.571
8	3.55	3.51	3.59	9.898	26.72	3.06	2.91	3.390
9	3.66	3.62	3.70	10.52	28.41	3.25	3.09	3.187
10	3.71	3.67	3.75	10.81	29.19	3.34	3.17	3.101
11	3.81	3.77	3.85	11.40	30.78	3.52	3.34	2.938
12	3.94	3.9	3.98	12.19	32.92	3.77	3.58	2.746
13	4	3.96	4.04	12.57	33.93	3.88	3.69	2.663
14	4.26	4.22	4.3	14.25	38.48	4.40	4.18	2.345

Note : No negative tolerance shall be permitted on the nominal diameter of Aluminium wires used in the construction of AAA conductor. Only positive tolerance of +1 percent shall be permitted on the nominal diameter specified in the above table as per IS 398 Part (IV) amended upto date.

7.1 MATERIAL :

The wire shall be of heat treated aluminium , magnesium silicon alloy having a composition appropriate to the mechanical and electrical properties specified in table above. The chemical composition shall confirm IS 1997-91 as given below.

Sr. no	Elements	Percent
1	Si	0.50-0.90
2	Mg	0.60-0.90
3	Fe	0.50max
4	Cu	0.10max
5	Mn	0.03max
6	Cr	0.03max

7	Zn	0.10max
8	B	0.06max
9	Other element (Each)	0.03max
10	Other element (Total)	0.10max
11	Al	Reminder

7.2 PHYSICAL CONSTANTS FOR ALUMINUM ALLOY WIRE:

a) RESISTIVITY :

As per amendment No 1 (May 2000) to IS398 part 4 : 1994 The maximum value of resistivity of any single aluminium alloy wires **0.0328 ohm mm ^{2} / m at 20°C** of any single aluminium alloy wire shall be used for calculation.

b) DENSITY :

At a temperature of 20 deg. C, the density of aluminum alloy is to be taken as **2.70 kg/cm^3.**

c) CONSTANT – MASS TEMPERATURE CO-EFFFICIENT (α):

At a temperature of 20°C, the Constant – Mass temperature Co-efficient of resistance of aluminum alloy wires, measured between two potential points rigidly fixed to the wire, is to be taken as **0.00360 / ^{0}C.**

d) CO-EFFFICIENT OF LINEAR EXPANSION:

The Co-efficient of linear expansion of aluminum alloy wire is to be taken as **23 x 10^{-6}/ ^{0}C.** This value holds good for all practical purposes over the range of temperatures from zero degree centigrade to highest safe operating temperature.

8. FREEDOM FROM DEFECTS:

The wires shall be smooth and free from all imperfections such as spills, splits, slag inclusion, die marks, scratches, fittings, blow-holes, projections, looseness, overlapping of strands, chipping of aluminium alloy layers etc. and all such other defects, which may hamper the mechanical and electrical properties of the conductor. Special care should be taken to keep away dirt, grit etc. during stranding**.**

9. JOINTS. IN WIRES :

a) Conductors containing seven wires :-

There shall be no joint in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.

b) Conductors containing more than seven wires :-

In conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the brass rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor, such joint shall be made by resistance or cold pressure butt welding. They are not required to fulfill the mechanical requirement of unjointed wires. Joints made

by resistance butt welding shall, subsequent to welding, be annealed over a distance of at least 200 mm on each side of the joint.

10. STRANDING :

a) The wires used in the construction of a stranded conductor shall, before stranding satisfy all the relevant requirements of IS 398 standard .

b) The lay ratio of the different layers shall be within the limits given in the Table-3

TABLE - III : LAY RATIOS FOR ALUMINIUM ALLOY STRANDED CONDUCTORS

Sr.no	No of wires in conductor	Lay Ratios			
		3/6 layers		12 layers	
		Min	Max	Min	Max
1	3	10	14	-	-
2	7	10	14	-	-
3	19	10	16	10	14

c) In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right handed . The wires in each layer shall be evenly and closely stranded.

d) In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

11. A) STANDARD LENGHT:

The standard length of AAA Conductor shall be 2 (two) kms. Tolerance of ± 5% (plus or minus five percent) shall be permitted. All the lengths outside these limits of tolerances shall be treated as random length.

Random length shall not be less than 80% (eighty percent) of the standard length specified as above and the total acceptable quantity of such random lengths shall be within7%(seven percent) quantity of the allotted quantity to each consignee of the respective size of the conductor.

B) VERIFICATION OF LENGTH OF CONDUCTOR:

i) The MSEDCL representative shall ascertain the length of AAA Conductor at supplier's works and at the receiving store centers by measuring the actual length by length measuring machine used for the purpose. The supplier should ensure that length measuring machine is available for measurement of the length by our inspecting officer.

ii) Both ends of the AAA Conductor will be sealed by the supplier and seals will be contained in the drum and not exposed out of drum.

iii) The declared length will be measured between manufacturer's seals at both ends of AAA Conductor.

iv) The weight of AAA Conductor will also be checked for ensuring correct lay and length of the AAA Conductor.

v) For the verification of the length of the conductor, 10 % of total lot (in Drums) should be selected at the works. The physical verification of the length of the conductor should be carried out for maximum up to 5 (five) drums. If there are anymore drums left for verification, then weight of each verified drum should be carried out and average weight may be calculated.

Then the weight of each of all the remaining selected drums may be taken and if these weights are matching with the average weight, then that particular lot may be accepted otherwise rejected.

vi) Verification of length of conductor will also be carried out at each stores center for two drums out of each lot. If the average length is found correct or more, the lot will be accepted. If the average length is found to be less than the declared, the percentage of such short length will be applied for reduction for the entire quantity supplied in the lot at respective stores for acceptance.

12. TESTS:

12.1 Selection of Test Samples:

The samples of individual wires for the test shall normally be taken before stranding. The test sample length criteria of should be as per clause no 12.1.1 of IS 398 (part 4). However, If desired by MSEDCL at the time of placing order the test be made in presence of MSEDCL representative, samples of wire shall be taken from length of stranded conductor. The samples shall be obtained by cutting 1.2 meters from the outer end of the finished conductor not more than 10 percent of finished drum. Also **the electrical & mechanical properties of aluminium alloy wire shall be ordinarily be made before stranding**.

The wires used for alloy conductor shall comply with the following test as per IS 398 (Part- 4)

a. Breaking Load Test.

b. Elongation Test.

c. Resistance Test.

12.2 TESTING EXPENSES:

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price except for the expenses of the inspector/ MSEDCL representative

12.3 ADDITIONAL TESTS:

The MSEDCL representative reserves the right of having at his own expenses any other test (s) of reasonable nature carried out at Manufacturer's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that materials comply with the specifications.

12.4 TEST REPORTS :

a) Record of routine test reports shall be maintained by the manufacturer at his works for periodic inspection by the MSEDCL representative.

b) Test certificates of tests during manufacture shall be maintained by the manufacturer. These shall be produced for verification as and when desired by the MSEDCL representative.

13 INSPECTION :

All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities without charges, to satisfy him that the material is being furnished in accordance with this specification.

14 MARKING :

Each drum shall have the following information stenciled on it in indelible ink alongwith other essential data:

a) Contract / Award letter number.

b) Name and address of consignee.

c) Manufacturer's name and address.

d) Drum number.

e) Size of conductor.

f) Length of conductor in meters.

g) Gross weight of drum with conductor.

h) Gross weight of drum without lagging.

i) Weight of empty drum with lagging.

j) Barrel diameter at three locations and an arrow marking at the location of measurement

k) Arrow marking for unwinding.

l) Position of the conductor ends.

m) ISI certification mark.

15 REJECTION :

i. While measuring the length , the sample piece from each length shall be taken for carrying out the test as per IS: 398 (Part IV) / 1994 (amended upto date). All the values of each sample should not exceed the value as per the relevant IS. In case of deviation , whole lot will be rejected at works.

ii. Specific resistivity of Aluminium Alloy wire used should not exceed 0.0328 ohm sq.mm./m at 20 degree centigrade as prescribed in IS: 398 (Part IV)/1994 (amended upto date). If the results are at variance , whole lot shall be rejected.

iii. The Guaranteed Technical Particulars attached with this specifications for the Conductor being supplied shall be provided with the Bid as specified in the Technical Specification. The Bids without the Guaranteed Technical Particulars shall be treated as Non-Responsive. The tenderer shall also submit Resistance and Mass of conductor and breaking Load of conductor calculations alongwith GTP.

16. BIS CERTIFICATION MARK :

The AAA Conductor with BIS (ISI) marking only is required by the MSEDCL against this specification and as such, only those tenderers who hold valid BIS license for AAA Conductor need quote against this invitation of tender.

17. SCHEDULES :

The tenderer shall fill following schedules which form part of the tender specifications and offer.

Schedule A - GUARANTED TECHNICAL PARTICULARS (Annexure- A)

Schedule B – Tenderer’s Experience

ANNEXURE-A

GUARANTED TECHNICAL PARTICULARS OF AAAC …… Sq.mm CONDUCTOR

SR. NO.	DESCRIPTION	UNIT	PARTICULARS
1.	NAME OF MANUFACTURER		
2	Works ADDRESS OF MANUFACTURER		
3	Brand Name		
4	BIS No. & Valid date		
4	Applicable Standard		
5	Size & Name of Conductor		
6	Manufacturers of Raw material		
7	Aluminum alloy composition		
	a) Si		
	b) Mg		
	c) Fe		
	d) Cu		
	e) Mn		
	f) Cr		
	g) Zn		
	h) B		
	i) Other element (Each)		
	j) Other element (Total)		
	k) Al		
8	Aluminum Alloy wire details		
a)	Diameter i) Nominal	mm	
	ii) Maximum	mm	
	iii) Minimum	mm	
b)	Cross sectional area of nominal wire diameter	mm^2	
c)	Mass	Kg/km	
d)	Minimum Breaking Load		
	i) Before Stranding	kN	

	ii) After Stranding	kN	
e)	Resistance at 20ºC Max	Ohms/km	

9	Aluminum Alloy Stranded Conductor		
a)	Actual Area	mm^2	
b)	Stranding and wire Dia	mm	
c)	Approximate Overall Dia	mm	
d)	Approximate Mass	Kg/km	
e)	Calculated Maximum Resistance at 20°C	Ohms/km	
f)	Approximate calculated Breaking Load	kN	
10	Final Modulus Elasticity	Kg/cm^2	
11	Coefficient of Linear expansion	/°C	
12	Direction of lay & lay ratio		
13	Maximum working tension		
14	Tolerance, if any, on standard lengths		
15	No. of standard lengths in one Drum		
16	Weight of the conductor in one Drum	kg	
17	Weight of the Drum	kg	
18	Gross weight of the reel including weight of the conductor	kg	
19	Drum (reel) details		
20	a) Dimensions of the Drum		
21	b) whether the drum on which the conductor is wound conforms to the specification		
22	Complete conductor to be purchased directly form the conductor manufacturer only		
23	Important packing & markings: for the detailed package and markings please refer the specification.		