



Maharashtra State Electricity Distribution Company Limited

SPECIFICATION NO. T&QC: MSC I / ACSR Conductor/2019/05

TECHNICAL SPECIFICATION

FOR

ACSR CONDUCTOR

FOR

DISTRIBUTION SYSTEM

IN

MSEDCL

SPECIFICATION NO. T&QC: MSC I / ACSR Conductor/2019/05

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MAHARASHTRA STATE ELECTRICITY DISTRIBUTION COMPANY
Technical Specifications for
ACSR Conductor
SPECIFICATION NO. T&QC: MSC I / ACSR Conductor/2019/05

1. SCOPE:

Specification covers the design, manufacture, testing at works and supply of **Aluminium conductor steel reinforced conductors** use in the distribution network 33/22/11 kV, 50 HZ. as per IS : 398 (Part II) 1996, IS : 1778 before dispatch, packing and delivery FOR destination. All Size of conductor shall be supplied with ISI mark

2. SERVICE CONDITIONS:

The ACSR 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	Siesmic level (Horizontal Acceleration)	0.3 g

Moderately hot and humid tropical climate conducive to rust and fungus growth

3. SYSTEM DETAILS:

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

S. N.	Particulars	Details		
1.	System Voltage (KV)	33	22	11
2.	Maximum Voltage (KV)	36	24	12
3.	Frequency (Hz)	50	50	50
4.	Lightning impulse withstand voltage(Dry and wet) (KVp)	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 -2) / 1996	Specifications of Aluminium conductors for overhead transmission purpose
2	209:1992	Zinc ingot (fourth revision)
3	IS : 1778/1980	Reels and Drums for bare conductors
4	IS : 4826/1979	Hot dipped galvanized coating on round steel wires
5	IS : 1885(part-32) /1993	Electro technical vocabulary
6	IS : 5484	E.C.Grade Aluminum rod produced by continuous casting and rolling
7	IS : 7623/1993	Lithium base grease for industrial purpose (second revision)

5. GENERAL TECHNICAL REQUIREMENT:

- a) ACSR 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.
- b) The conductor shall therefore be suitable for satisfactory operation under the tropical climatic conditions listed under the clause 2.0. The applicable design particulars of the conductor to be used on the lines shall be furnished in GTP (Annexure-A).

6. MATERIAL :

The conductor shall be constructed of Hard-drawn aluminum and galvanized steel wires have mechanical and electrical properties specified in table above and must have to follow respective IS. The zinc used for galvanizing shall be electrolyte high grade zinc not less than **99.95 %** purity. The chemical composition of high carbon steel shall be as given below

Sr. no	Elements	Percent
1	Carbon	0.50 to 0.85
2	Manganese	0.50 to 1.10
3	Phosphorus	Max. to 0.035
4	Sulphur	Max 0.045
5	Silicon	0.10 to 0.35

7. PROPERTIES OF ALUMINUM WIRES & STEEL WIRES USED IN CONSTRUCTION OF ACSR CONDUCTORS :

7.1 The Properties of **Aluminum wires** use to construct stranded ACSR conductor 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	1.50	1.48	1.52	1.767	4.78	0.32	0.30	16.432
2	1.96	1.94	1.98	3.017	8.16	0.54	0.51	9.561
3	2.11	2.09	2.13	3.497	9.45	0.63	0.60	8.237
4	2.59	2.56	2.62	3.269	14.24	0.89	0.85	5.49
5	3	2.97	3.03	7.069	19.11	1.17	1.11	4.079
6	3.18	3.15	3.21	7.942	21.47	1.29	1.23	3.626
7	3.35	3.32	3.38	8.814	23.82	1.43	1.36	3.265

7.1.1 PHYSICAL CONSTANTS FOR HARD DRAWN ALUMINUM WIRE:

a) RESISTIVITY :

The standard value shall be used for calculation is to be taken as **0.028264** ohm mm² / m at 20°C.

b) DENSITY :

At a temperature of 20°C, the density of hard drawn aluminum alloy is to be taken as **2.703** g/cm³.

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

At a temperature of 20°C, the Constant – mass temperature Co-efficient of resistance of hard drawn aluminum measured between two potential points rigidly fixed to the wire, is to be taken as **0.00403°C**.

d) CO-EFFICIENT OF LINEAR EXPANSION:

The Co-efficient of linear expansion of hard drawn aluminum has been taken as **23x10⁻⁶/°C**. This value holds good for all practical purposes over the range of temperatures from zero degree centigrade to highest safe operating temperature.

7.2.1 The Properties of **Steel wires** use to construct stranded ACSR conductor must be as follows:

S.N.	Nominal Diameter (mm)	Actual Diameter(mm)		Cross sectional area of Nominal Diameter wire (mm ²)	Mass (Kg/Km)	Minimum Breaking Load (kN)	
		Min	Max			Before Stranding	After Stranding
1	1.50	1.47	1.53	1.767	13.78	2.46	2.34
2	1.57	1.54	1.6	1.936	15.10	2.70	2.57
3	1.96	1.92	2	3.017	23.53	4.20	3.99
4	2.11	2.07	2.15	3.497	27.27	4.60	4.37

5	2.3	2.25	2.35	4.155	32.41	5.46	5.19
6	2.59	2.54	2.64	5.269	41.09	6.92	6.57
7	3	2.94	3.06	7.069	55.13	9.29	8.83

Note : The Tolerance of +1 percent shall be permitted on the nominal diameter specified in table as per IS 398 Part (II) and No negative tolerance shall be accepted.

7.2.2 PHYSICAL CONSTANTS FOR GALVANISED STEEL WIRE:

a) DENSITY :

At a temperature of 20⁰C, the density of galvanized steel wire is to be taken as 7.8 g/cm³.

b) CO-EFFICIENT OF LINEAR EXPANSION:

The Co-efficient of linear expansion of galvanized steel wire is to be taken as 11.5x10⁻⁶/⁰C.

8. PRINCIPAL PARAMETERS OF ACSR CONDUCTOR :

The properties of stranded ACSR conductors of various sizes shall be as in Table – 1

Table-1

S. n.	Actual Area (mm ²)	Stranding and Wire Dia (mm)		Sectional area of aluminum (mm ²)	Total sectional area (mm ²)	Approx Dia (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 (/°C)
		Al.	Steel								
1	10	6/1.50	1/1.5	10.60	12.37	4.50	43	2.78	3.97	79	19.1x10 ⁻⁶
2	18	6/1.96	1/1.96	18.10	21.12	5.88	73	1.618	6.74	79	19.1x 10 ⁻⁶
3	20	6/2.11	1/ 2.11	20.98	24.48	6.33	85	1.394	7.61	79	19.1x 10 ⁻⁶
4	30	6/2.59	1/ 2.59	31.61	36.88	7.77	128	0.9289	11.12	79	19.1x 10 ⁻⁶
5	50	6/3.35	1/3.35	52.88	61.70	10.05	214	0.5524	18.25	79	19.1x 10 ⁻⁶
6	80	6/4.09	1/ 4.09	78.83	91.97	12.27	319	0.3712	26.91	79	19.1x 10 ⁻⁶
7	100	6/4.72	7/1.57	105.0	118.50	14.15	394	0.2792	32.41	75	19.8x 10 ⁻⁶
8	150	30/2.59	7/2.59	158.1	194.90	18.13	726	0.1871	67.34	80	17.8x 10 ⁻⁶
9	200	30/3	7/3	212.1	261.50	21.00	974	0.1390	89.67	80	17.8x 10 ⁻⁶

9. FREEDOM FROM DEFECTS:

The wires shall be smooth and free from all imperfections such as spills & splits. 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.

10. JOINTS. IN WIRES :

The wires shall be drawn in continuous length without joint except those made in wire rod or before drawing operation.

10.1 Joints in aluminum wire

a) Conductors containing seven wires :-

There shall be no joint in any wire of a stranded conductor containing seven wires.

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.

10.2 Joints in galvanized steel wires:

No joints permitted in the finished coated steel wires.

11. STRANDING :

- a) The wires used in the construction of a ACSR conductor shall , before stranding satisfy all the relevant requirements of this standard .
- b) The lay ratio of the different layers shall be within the limits given in the Table-II

TABLE - II : LAY RATIOS FOR ALUMINIUM ALLOY STRANDED CONDUCTORS

Sr.no	No of wires		Ratio of aluminum wire diameter to steel wire diameter	Lay ratio for steel core (6 wire layers)		Lay ratios for aluminum wire					
	Alu	Steel		Min	Max	Outer most layer		Layer immediately beneath outermost layer		Innermost layer of conductors with 3 aluminum wire layers	
						Min	Max	Min	Max	Min	Max
1	6	1	1	-	-	10	14	-	-	-	-
2	6	7	3	13	28	10	14	-	-	-	-
3	30	7	1	13	28	10	14	10	16	-	-

- c) In conductors having multiple layers of aluminum wires, the lay ratio of any aluminum layers shall be not greater than the lay ratio of the aluminum layer immediately beneath it.
- d) steel wire shall be formed during stranding so that they remain intact when conductor is cut for jointing operations.

11. A) STANDARD LENGHT:

The standard length of AAA Conductor shall be 2 (two) kms. Tolerance of $\pm 5\%$ (plus or minus five percent)shall be permitted in this standard length. 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 within 7% (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 Company 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. 12.1 TEST:

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 13.1.1 of IS 398 (2). 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.

The ACSR conductor shall comply with the following test as per IS 398 (Part-2)

12.1 Surface condition test

12.2 Test for ultimate breaking load on stranded conductor

12.3 Stress Strain test.

12.4 Measurement of diameter of individual aluminium and steel wire.

12.3 Measurement of lay ratio

12.4 Breaking load of individual wires

12.5 Ductility test

12.6 Wrapping test

12.7 Resistance test

12.8 Galvanised 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 and Type 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) BIS 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 II) / 1996 (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) The standard value shall be used for calculation is to be taken as $0.028264 \text{ ohm mm}^2 / \text{m}$ at 20°C as prescribed in IS: 398 (Part II)/1996 (amended upto date). If the results are at variance, whole lot shall be rejected.
- iii. The Guaranteed Technical Particulars 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 ACSR Conductor with BIS (ISI) marking only is required by the MSEDCL against this tender specification and as such , only those tenderers who hold valid BIS license for ACSR 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 - GUARANTEED TECHNICAL PARTICULARS (Annexure- A)

Schedule B – Tenderer’s Experience

ANNEXURE- A

GUARANTED TECHNICAL PARTICULARS OF ACSR Sq.mm CONDUCTOR

SR. NO.	DESCRIPTION	UNIT	PARTICULARS
1.	NAME & ADDRESS OF MANUFACTURER		
2	Brand Name		
3	Applicable Standard		
4	BIS No & validity date		
5	Size & Name of Conductor		
6	Manufacturers of Raw material		
7	Composition of high carbon steel		
	a) Carbon		
	b) manganese		
	c) Phosphorus		
	d) Sulphur		
	e) Silicon		
8	Purity of electrolytic high grade zinc use for galvanizing		
9	Aluminum 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 20°C Max	Ohms/km	
f)	Physical constant for hard drawn aluminum wire		
	i) Resistivity		
	ii) Density		
	iii) Constant mass Temperature coefficient		

	iv) Coefficient of linear expansion		
10	Still 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	
f)	Physical constant for still wire		
	i) Resistivity		
	ii) Coefficient of linear expansion		
11	ACSR Conductor		
a)	Actual Area	mm ²	
b)	Stranding and wire Dia	mm	
	i) Aluminum		
	ii) Steel		
c)	Sectional Area of aluminum	mm ²	
d)	Total Sectional Area	mm ²	
e)	Approximate Overall Dia	mm	
f)	Approximate Mass	Kg/km	
g)	Calculated Maximum Resistance at 20°C	Ohms/km	
h)	Approximate calculated Breaking Load	kN	
12	Final Modulus Elasticity	Kg/cm ²	
13	Coefficient of Linear expansion	/°C	
14	Direction of lay & lay ratio		
15	Maximum working tension		
16	Tolerance, if any, on standard lengths		
17	No. of standard lengths in one Drum		
18	Weight of the conductor in one Drum	kg	
19	Weight of the Drum	kg	

20	Gross weight of the reel including weight of the conductor	kg	
21	Drum (reel) details		
22	a) Dimensions of the Drum		
23	b) whether the drum on which the conductor is wound conforms to the specification		
24	Complete conductor to be purchased directly from the conductor manufacturer only		
25	Important packing & markings: for the detailed package and markings please refer the specification.		