Maharashtra State Electricity Distribution Company Limited

SPECIFICATION NO. MMC: MSC-II / AL 59 conductor /2018/10/01

TECHNICAL SPECIFICATION

FOR

AL-59 CONDUCTOR

FOR

DISTRIBUTION SYSTEM

IN

MSEDCL

I N D E X

MAHARASHTRA STATE ELECTRICITY DISTRIBUTION COMPANY
Technical Specifications for
AL-59 CONDUCTOR

1. SCOPE:

a. Specification covers the design, manufacture, testing at works and supply of **AL 59 conductor conforming SS 4240813, SS 4240814 (swedish standard)** ,IS : 398(Part IV/V) 1994, IS : 1778 before dispatch, packing and delivery FOR destination **..**The system shall be A.C. 3 phase, 3 wires, 33/22/11 kV, 50 HZ.

2. SERVICE CONDITIONS:

The AL59 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 conductive to rust and fungus growth ….

3. SYSTEM DETAILS:

AL59 conductor are meant for erection of 33,22,11kV lines with relevant parameters as under:-

Sr. No..	Particulars	Details		
1.	System Voltage	33	22	11
2.	Maximum Voltage	36	24	12
3.	Frequency	50 Hz	50 Hz	50 Hz
4.	Lightening 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:

a. SS :4240813**(** swedish standard) for AL59 conductors.
b. SS :4240814**(** swedish standard) for AL59 conductors.
c. IS : 398(Part IV/V) 1994.

d. IS : 1778.

5. GENERAL TECHNICAL REQUIREMENT:

a) AL59 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 is furnished in Annexure-II "system particulars".

6. PRINCIPAL PARAMETERS:

Technical Specification for AL-59 conductor is as under :-

Sr. No..	Particulars	AL 59 conductor size			
		34	55	108.9	261.5
1.	Typical factors	7/2.50	7/3.15	7/4.26	37/3
2.	Conductor diameter in MM	7.5	9.45	12.78	21
3.	Cross section area	34.36	54.55	99.77	261.5
4.	Coefficient of linear expansion /°C	23×10^{-6}	23×10^{-6}	23×10^{-6}	23×10^{-6}
5.	Mass per unit length kg/km	93.88	149.20	272.88	721
6.	Breaking Load (kN)	8.61	13.65	22.95	65.49
7.	DC Resistance at 20deg. C ohm/km	0.8563	0.5394	0.2949	0.1133
8.	Direction of outermost Layer	Right-hand	Right-hand	Right-hand	Right-hand

7. PHYSICAL CONSTANT OF MATERIAL:

The AL-59 should be as per SS 4240814 and its latest amendments. The material offered shall be of the best quality and workmanship. The AL-59 shall have accurate chemical composition of alloy so as to offer excellent corrosion resistance, better strength of weight ratio and improved conductivity. The solution treatment shall be done in a very sophisticated and advanced technology furnace with automatic quenching system.

8. RESISTIVITY :

The resistivity of AL-59 depends upon its purity and its physical condition. For the purpose of this specification the maximum value of the wire strand Per kilometer at 20deg.C shall be as per SS4240813 and this value shall be used for calculation of maximum permissible value of resistance.

9. DENSITY :

At a temperature of 20deg. C, the density of hard drawn aluminum alloy has been taken as 2.70 g/cm3.

10. CONSTANT – MASS TEMPERATURE CO-EFFFICIENT (α):

At a temperature of 20^0 C, the Constant – mass temperature Co-efficient of resistance of hard drawn aluminum alloy measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.0038 per degree Celsius.

11. CO-EFFFICIENT OF LINEAR EXPANSION:

The Co-efficient of linear expansion of hard drawn aluminum alloy has been taken as $23x10^{-6}/^0C$. This value holds good for all practical purposes over the range of temperatures from zero degree centigrade to highest safe operating temperature.

12. MATERIAL:

a) Aluminium alloy:

The conductor shall be manufactured from alloy grade aluminium rods suitably hard-drawn on wire drawing machines. The mechanical and electrical properties of aluminium alloy wire shall comply with the requirements given SS4240813 relevant standard.

b) 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.

13. WIRE SIZES:

a) Nominal size :

The aluminium alloy for the stranded conductor covered by this standard shall have diameters specified in clause 6.0.

b) Tolerances on normal size:

A tolerance of +/-1% is permitted on the nominal diameter of Conductor.

NOTE : In order to maintain the circularity of the wires the tolerance allowed shall apply to both the measurements at right angles taken at the same cross-section as per clause 2.2 of IS:398 (Part IV) Third Revision and SS4240813/4240814.

14. JOINTS IN WIRE:

No joints shall be permitted in the aluminium alloy wires in the outermost layer of the AL59 conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 meters apart in the complete stranded conductor. Such joints shall be made by cold pressure butt-welding.

NOTE : Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses on the extra high voltage lines

15. STRANDING:

The lay ratio of the different layers shall be within the limits given in the table below.

NUMBER OF WIRES	WIRE LAYER 1 LAY RATIO		WIRE LAYER 2 LAY RATIO		WIRE LAYER 3 LAY RATIO	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
7	12	14	--	---	--	---
19	12	14	11	13	--	---
37	10	17	16	18	10	14

NOTE: For the purpose of calculation, the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table.

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

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

16. STANDARD LENGHT:

The Standard Length of the conductor shall be 1500 meters. A tolerance of +/- 5% on the standard length offered by the Bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.

Random lengths will be accepted provided no length is less than 70% of the standard length and total quantity of such random lengths shall not be more than 10% of the quantity ordered. When one number random length has been manufactured at any time, five (5) more individual lengths, each equivalent to the above random length with a tolerance of +/- 5% shall also be manufactured and all the above six random lengths shall be despatched in the same shipment. At any point, the cumulative quantity supplied including such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.

Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The MSEDCL representative reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during tendency of the contract.

NOTE: "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 GTPs shall also include creep calculations.

17. TEST AND STANDARDS:

The Type Test, Acceptance Tests and routine tests during manufacture, shall be carried out on the conductor as per the IS-398 (part-4) of 1996 and latest revision of SS 4240813/SS 4240814.

The conductor offered should be type tested for all the type tests. Test reports should not be more than seven years old reckoned from the date of bid opening in respect of all the testes carried out from Govt./Govt. approved reputed test house or at accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of MSEDCL or Utility shall be submitted alongwith the Bid.

In the event of non-availability of test report or any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Supplier at no extra cost to the Employer/ Purchaser.

Acceptance tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-despatch inspection, for the purpose of acceptance of that lot.

Routine tests shall mean those tests, which are to be carried out on each strand/ spool/length of the conductor to check requirements which are likely to vary during production.

Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the manufacture to ensure the desired quality of the end product to be supplied by him.

Samples for individual wires for tests shall be taken before stranding from not less than ten percent of the spools in the case of aluminium alloy wires. If samples are taken after stranding, they shall be obtained by cutting 1.2 metres from the outer end of the finished conductor from not more than ten percent of the finished reels.

The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be as specified in Annexure-II or as mutually agreed to between the Bidder and the Purchaser in the Quality Assurance Program.

For all acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the guaranteed technical particulars of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

18. 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.

19. 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.

20. 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

21. INSPECTION :

The MSEDCL representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the manufacturer works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

The manufacturer shall keep the MSEDCL representative informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

The supplier shall give 15 days advance intimation to enable the purchaser to depute his representative for witnessing acceptance and routine tests.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the MSEDCL representative in writing. In the later case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by the following method:

"At the works of the manufacturer of the conductor, the conductor shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley & Cyclometer. The difference in the average length thus obtained and as declared by the Bidder in the packing list shall be applied to all the drums if the conductor is found short during checking."

At least 10% of the total drums in any lot put up for inspection, shall be selected at random to conduct the "Acceptance Tests" by the inspector. The acceptance Tests shall be carried out on all the samples drawn from the sampling drums selected as above. If any sample drawn does not pass the Acceptance tests, the drum from which the sample is drawn will be rejected and another drum from the same lot shall be selected at random to repeat the "Acceptance Tests". **If the second sample also fails in the same Test, the entire lot offered for Inspection will be rejected.**

The acceptance of any quantity of material shall in no way relieve the manufacturer of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

Approval of drawing/TCs by Purchaser shall not relieve the Bidder of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The material

shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering and Purchaser shall have the power to reject any work or material , which in his judgment is not in full accordance therewith.

22. TEST FACILITIES :

The following additional test facilities shall be available at the manufacturer's works:

a) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.

b) Standard resistance for calibration of resistance bridges.

c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

23. PACKING FOR CONDUCTOR:

The Conductor shall be supplied in non-returnable, strong, wooden/ steel drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handing and stringing operations in the field. The manufacturer shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The drums shall generally conform to IS: 1778-1980, except as otherwise specified hereinafter.

The drums shall be suitable for wheel mounting and for letting off the Conductor under a minimum controlled tension of the order of 300kg.

For conductor, one standard length shall be wound on each drum.

In any one drum, maximum four standard lengths are permissible.

If, the drum carries more than one length, measurement of each length of conductor and total of all of them shall be marked on drum. The outermost length on drum shall be numbered as first and the innermost shall be numbered as last.

All wooden components shall be manufactured out of seasoned soft wood free free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti fungus (Aldrime / Aldruse) shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.

The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not very by more than 3 mm from that indicated in the figure. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in line with the periphery of the barrel.

The wooden battens used for making the barrel of the conductor shall be segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

Barrel studs shall be used for the construction of drums. The flanges shall be holed

and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

The inner check of the flanges and drum barrel surface shall be painted with bitumen based paint.

Before reeling, cardboard or double corrugated or thick bitumen zed waterproof bamboo paper or woven HDPE sheet shall be secured to the drum barrel and inside of flanges or the drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective lagging and outer layer of the conductor.

Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

Outside the protective lagging, there shall be minimum of two binder consisting of hoop iron/ galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.

The conductor ends shall be properly sealed on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

24. 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 measuremen

k) Arrow marking for unwinding.

l) Position of the conductor ends.

ANNEXURE-I

TEST PROCEDURE

UTS TEST ON STRANDED CONDUCTOR:

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to (50%) and held for one minute, the circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to (100%). The applied load shall then be increased until the failing load is reached and the value recorded.

SURFACE CONDITION TEST :

A sample of the finished conductor for use in 220 KV system having a minimum recommended length of 5 meters with compression type dead end clamps compressed on both ends in such a manner as to permit the conductor to take its normal straight line shape, shall be subjected to a tension of 50 percent of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place or disturb the longitudinal smoothness of conductor. The measured diameter at any place shall be not be less than the sum of the minimum specified diameters of the individual aluminium and steel strands as given in this specification.

D.C. RESISTANCE TEST ON STRANDED CONDUCTOR:

On a conductor sample of minimum 5m lengths two contact clamps shall be fixed with a pre- determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value shall be recorded. The value obtained shall be corrected to the value at 20 deg. C as per Clause No. 12.8 of IS: 398 (Part V) / 1996. The resistance corrected at 20 deg. C shall conform to the requirements of this specification.

CHEMICAL ANALYSIS OF ALUMINIUM :

Samples taken from the Aluminium ingots/coils/strands shall be chemically / spectrographically analyzed. The same shall be in conformity to the particulars guaranteed by the bidder so as to meet the requirements stated in this specification.

VISUAL AND DIMENSIONAL CHECK ON DRUM :

The drums shall visually and dimensionally check to ensure that they conform to the requirements of this specification.

VISUAL CHECK FOR JOINTS, SCRACHES ETC. :

Conductor drums shall be rewound in the presence of the inspecting officer. The inspector shall visually check the scratches, joints, etc. and that the conductor generally conforms to the requirements of the specification.

DIMENSIONAL CHECK OF ALUMINIUM STRANDS :

The individual strands shall be dimensionally checked to ensure that they conform to the requirements to this specification.

CHECK FOR LAY RATIOS OF VAIOUS LAYERS :

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification.

BREAKING LOAD TEST ON WELDED ALUMINIUM STRAND :

Two Aluminum Alloy wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand at least 90% of the minimum breaking load of the individual strand specified in this specification.

ANNEXURE-II

GUARANTED TECHNICAL PARTICULARS OF AL59 C0NDUCTOR

SR. NO..	DESCRIPTION	UNIT	PARTICULARS
1.	NAME & ADDRESS OF MANUFACTURER		
2.	Quality of material and standard to which conform		
3.	Number of strands		
4.	Diameter of stands (AL-59)		
	(a) Nominal	mm	
	(b) Maximum	mm	
	(c) Minimum	mm	
5.	Overall diameter of conductor	mm	
6.	Cross sectional area of		
	a) whole conductor	Sq. mm	
	b) each stand	Sq. mm	
7.	Purity of aluminium rods – min	%	
8.	Number of stands		
	(a) Centre	No.	
	(b) 7 wire Aluminium layer	No.	
	© 19 wire Aluminium layer	No.	
9.	Weight of		
	a) whole conductor	Kg/km	
	b) aluminium alloy strand (at nominal dia)	Kg/km	
10.	Calculated D.C. resistance at 200 deg.C		
	a) whole conductor	ohm/km	
	b) aluminium alloy strand	ohm/km	

SR. NO..	DESCRIPTION		UNIT	PARTICULARS
11.	Ultimate tensile strength			
	i) Whole conductor		KN	
	ii) min breaking load before stranding			
	a) AL-59 strand		KN	
	iii) Min breaking load after stranding			
	a) AL-59 strand		KN	
12.	Modulus of elasticity of			
	a) AL-59 strand		Kg/sq.cm.	
	b) whole conductor		Kg/sq.cm.	
13.	Co-efficient of linear expansion per degree centigrade of			
	a) AL-59 strand		Per deg. C	
	b) whole conductor		Per deg. C	
14	Resistivity (maximum)		Ohms Sq.mm/mtr.	
	Lay ratios			
	AL-59	1st layer (6 wires)		
	AL-59	2nd layer (12 wires)		
15	Maximum working tension			
16	Tolerance, if any, on standard lengths			
17	No. of standard lengths in one reel			
18	Weight of the conductor in one reel		Kg	
19	Weight of the drum		Kg	
20	Gross weight of the reel including weight of the conductor		Kg	
21	Drum (reel) details			
	a) Dimensions of the reel			
	b) whether the drum on which the conductor is wound conforms to the specification			

22	Raw materials are to be procured directly from the primary producers so as to ensure the quality of raw materials. The test certificates of raw material and invoices shall be produced at the time of inspection.		
23	a) Manufacturer of AL-59 wire rod		
	b) Chemical Composition of AL59		
24	Complete conductor to be purchased directly form the conductor manufacturer only		
25	Important packing & markings: for the detailed package and markings please refer the specification.		