

- i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/ IEC vide 25/ 17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and
- ii) Type test reports contain valid Calibration reports of the relevant testing equipment and information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/ values specified in Technical Specification/ relevant standards (IS/ IEC) and compliance to the same and
- iii) Tests should have been conducted on the samples of clamps & accessories for HTLS conductor manufactured from same manufacturing works within last 7 (seven) years as on the date of NOA.

Further, test certificates of samples manufactured from same manufacturing works shall also be considered valid, if the same has already been approved/ accepted by POWERGRID & tests have been conducted within the above mentioned validity period.

In case the tests have been conducted earlier than the above stipulated period or carried out on samples manufactured from any other manufacturing works or in case of revision/ amendment in the provisions/ test procedure of the IS/IEC as referred in the TS or in the event of any discrepancy in the test report (i.e. due to non-inclusion of valid calibration certificate, desired information etc. or any test 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 Specifications), the tests shall be conducted by the supplier at no extra cost to the Purchaser.

3.2 Acceptance Tests

3.2.1 On Both Suspension Clamp and Tension clamp fitting for HTLS Conductor

a)	Visual Examination	IS 2486-(Part-I)
b)	Verification of dimensions	IS 2486-(Part-I)
c)	Galvanising/ Electroplating test	Annexure-A
d)	Mechanical strength test of each component	Annexure-A
e)	Mechanical Strength test of welded joint	Annexure-A

f)	Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings	Annexure-A
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3.2.2 On Suspension Clamp fitting for HTLS Conductor

a)	Slip strength test for suspension clamp	Annexure-A
b)	Shore hardness test of elastomer cushion for AG suspension clamp	Annexure-A
c)	Bend test for armour rod set	IS 2121(Part-I), Clause 7.10.
d)	Resilience test for armour rod set	Annexure-A
e)	Conductivity test for armour rods set	IS 2121(Part-I), Clause 7.5.

3.2.3 On Tension Clamp Fitting for HTLS Conductor

a)	Slip strength test for dead end assembly	Annexure-A
b)	Ageing test on filler (if applicable)	Annexure-A

3.2.4 On Mid Span Compression Joint for HTLS Conductor

a)	Visual examination and dimensional verification	IS 2121 (Part-II), Clause 6.2, 6.3 & 6.7
b)	Chemical analysis of materials	Annexure-A
c)	Galvanising test	Annexure-A
d)	Hardness test	Annexure-B
e)	Ageing test on filler (if applicable)	Annexure-A

3.2.5 On T-Connector for HTLS Conductor

a)	Visual examination and dimensional verification	IS2121 (Part-IV)
b)	Chemical analysis of materials	Annexure-A
c)	Axial tensile load test for welded portion	Annexure-A

3.2.6 On Repair Sleeve for HTLS Conductor

a)	Visual examination and dimensional verification	IS 2121(Part-II), Clause 6.2, 6.3
b)	Chemical analysis of materials	Annexure-A

3.2.7 On Spacer Damper for Line / Rigid Spacer for Jumper for twin HTLS conductor

a)	Visual examination and dimensional verification	IS 10162
b)	Chemical analysis of materials	Annexure-A
c)	Galvanising test	Annexure-A
d)	Movement test (except for rigid spacers)	IS 10162
e)	Clamp slip test	Annexure-B
f)	Clamp bolt torque test	IS 10162
g)	Compression-tension test	Annexure-B
h)	Assembly torque test	IS 10162
i)	Hardness test for elastomer (if applicable)	Annexure-B

3.2.8 On Vibration Damper for HTLS conductor

a)	Visual examination and dimensional verification	IS 9708
b)	Chemical analysis of materials	Annexure-A
c)	Verification of Resonance Frequencies	Annexure-B
d)	Strength of messenger cable test	Annexure-B
e)	Clamp slip test	Annexure-B
f)	Clamp bolt torque test	IS-9708
g)	Mass pull off test	Annexure-B
h)	Dynamic Characteristics test	Annexure-B
i)	Galvanizing/ Electroplating Test	Annexure-A

3.3 Routine Tests

3.3.1 For Hardware Fittings

a)	Visual examination	IS 2486 (Part-I)
b)	Proof Load Test	Annexure-A

3.3.2 For conductor accessories

a)	Visual examination and dimensional verification	IS 2121(Part-II)/ IS 2121 (Part IV)/ IS 9708/ IS 10162 as applicable
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3.4 Tests During Manufacture on all components as applicable

a)	Chemical analysis of Zinc used for galvanising	IS 2486 (Part-I)
b)	Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings	Annexure-A
c)	Chemical analysis, hardness tests and magnetic particle inspection for forging	Annexure-A

3.5 Testing Expenses

3.5.1 In the event of type testing, Bidder shall ensure that adequate facilities are available in the proposed laboratories and the tests can be completed in these laboratories within the time schedule.

3.5.2 In case of failure in any type test, the supplier is either required to modify the design of the material & repeat all the type tests once or to repeat that particular type test at least three times successfully at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

If repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/ Employer's representative shall be deducted from the contract price. Also, if on receipt of the Contractor's notice of testing, the Employer's representative/ Inspector does not find material & facilities to be ready for testing the expenses incurred by the Employer's for re-deputation shall be deducted from contract price.

- 3.5.3 The Contractor shall intimate the Employer about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of testing in India and at least 6 weeks advance in case of testing abroad) of the scheduled date of testing during which the Employer will arrange to depute his representative to be present at the time of carrying out the tests.
- 3.5.4 The entire cost of type tests, acceptance and routine tests and tests during manufacturing specified herein shall be treated as included in the quoted Ex-works, except for the expenses of the inspector/ Purchaser's representative.
- 3.6 **Sample Batch For Type Testing**
- 3.6.1 The Contractor shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Employer. The Contractor shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Employer.
- 3.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Employer's representative.
- 3.7 **Schedule of Testing and Additional Tests**
- 3.7.1 The Bidder has to indicate the schedule of following activities in their bids
- (a) Submission of drawing for approval.
 - (b) Submission of Quality Assurance programme for approval.
 - (c) Offering of material for sample selection for type tests.
 - (d) Type testing.
- 3.7.2 The Employer reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Contractor's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material complies with the specifications.
- 3.7.3 The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non-compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items, all without any extra cost to the Employer.

3.8 Test Reports

- 3.8.1 Copies of type test reports shall be furnished in at least six copies along with one original. One copy shall be returned duly certified by the Employer, only after which the commercial production of the concerned material shall start.
- 3.8.2 Copies of acceptance test report shall be furnished in at least six copies. One copy shall be returned, duly certified by the Employer, only after which the materials will be dispatched.
- 3.8.3 Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Employer's representative.
- 3.8.4 Test certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Employer.

3.9 Inspection

- 3.9.1 The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/ or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works, raw materials. Manufacturer's of all the material and for conducting necessary tests as detailed herein.
- 3.9.2 The material for final inspection shall be offered by the Contractor only under packed condition as detailed in clause 4.11 of this part of the Specification. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.
- 3.9.3 The Contractor shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.
- 3.9.4 Material shall not be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Employer in writing. In the latter case also the material shall be dispatched only after all tests specified herein have been satisfactorily completed.
- 3.9.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such materials are later found to be defective.

3.10 Packing and Marking

- 3.10.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

- 3.10.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 3.10.3 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 3.10.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.
- 3.10.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture. However, in such type of component/ item, which consists of many parts and are being supplied in assembled condition (suspension clamp, rigid spacer, spacer damper etc.), the complete assembly shall be legibly and indelibly marked on main body/on one of the parts. The symbol ☂ / alongwith the word 'TOP' shall be marked on the main body of the spacer damper for installing spacer damper in correct position.
- 3.10.6 All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.
- 3.11 **Standards**
- 3.11.1 The clamp fitting and accessories shall conform to the following Indian/ International Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.
- 3.11.2 In the event of the supply of clamp fitting and accessories conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

Sl. No.	Indian Standard	Title	International Standard
1	IS 209	Specification for zinc	
2	IS 398 (Part-V)	Aluminum Conductor Galvanised Steel- Reinforced For Extra High Voltage (400 KV) and above	
3	IS 1573	Electroplated Coating of Zinc on iron and Steel	

4	IS 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	
5	IS 2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
6	IS 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
7	IS 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8	IS 4826	Galvanised Coating on Round Steel Wires	
9	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	
10	IS 8263	Method of Radio Interference Tests on High Voltage Insulators	
11	IS 6639	Hexagonal Bolts for Steel Structures	
12	IS 10162	Specification for Spacers & Spacers Dampers for Twin Horizontal Bundle Conductors	
13	IS 9708	Stockbridge Vibration Damper for Overhead Power Lines- Specification	
14		Overhead Lines-Requirements and tests for Spacers	IEC 61854
15		Overhead Lines-Requirements and tests for fittings	IEC 61284

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonville Road, N - 19-ND UK
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva SWITZERLAND
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017 U.S.A.

Annexue-A

1.0 Tests on Hardware Fittings

1.1 Magnetic Power Loss Test for Suspension Assembly

The test shall be carried out as per clause no. 12 of IEC 61284 considering 50Hz AC of various magnitude (in steps of 50A) within $\pm 200A$ of specified ampacity at designed maximum temperature of HTLS conductor. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to specified ampacity at designed maximum temperature of the HTLS conductor shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

1.2 Mechanical Strength Test of Each Component

Each component shall be subjected to a load equal to the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached and the value recorded.

1.3 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kg for one minute. Thereafter, it shall be subjected to die-penetration/ ultrasonic test. There shall not be any crack at the welded portion.

1.4 Slip Strength Test for Suspension Clamp

The test shall be carried out as per Clause no. 11.1 of IS 2486 (Part-1) by keeping the clamp at minimum specified slip strength for one minute and considering slip strength as specified in the GTP.

1.5 Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2486 (Part-I) with following modifications: -

- i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor but not exceeding maximum permissible conductor temperature for short term operation guaranteed in the GTP.
- ii) Number of cycles: 100
- iii) Slip strength test shall also be carried out after heating cycle test.

1.6 Slip strength test for dead end assembly

The test shall be carried out as per IS 2486 (Part-I) except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor and retained for one minute at this load.

1.7 Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

1.8 Proof Load Test

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

1.9 Tests for Forging Casting and Fabricated Hardware

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as in the Quality Assurance programme.

1.10 Resilience test for armour rod set

The test shall be carried out as per IS 2121 (Part-I), except that the slip strength test after resilience test shall be conducted as per clause 1.4, Annexure-A of the TS and suspension assembly in this slip strength test shall withstand minimum slip load guaranteed in the GTP.

2.0 Slip Strength Test on Mid Span Compression Joint

The test shall be carried out as per IS 2121 (Part-II), clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor and retained for one minute at this load. There shall be no movement of the conductor relative to the fittings and no failure of the fittings during this one-minute period.

2.1 Heating Cycle Test on Mid Span Compression Joint & T- Connector

Heating cycle test shall be performed in accordance with IS 2121 (Part-II) with following modifications: -

- i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor but not exceeding maximum permissible conductor temperature for short term operation guaranteed in the GTP by the contractor/supplier.
- ii) Number of cycles: 100
- iii) Slip strength test shall also be carried out after heating cycle test.

2.2 Axial Tensile Load Test for Welded Portion of T-Connector

The sleeve portion of the T-Connector shall be compressed on conductor. The compressed portion shall be held rigidly on some fixtures and axial load shall be applied along with the jumper terminal. The load shall be increased gradually till breaking of welded joint occurs. The breaking load should be above 30 kN.

2.3 Vibration Damper

(a) Dynamic Characteristics, Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for aeolian vibration frequency band ranging from $0.18/d$ Hz to $1.4/d$ Hz (where d is conductor diameter in meter) for damper for conductor. The damper assembly shall be vibrated vertically with a ± 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at ± 0.5 mm to determine following characteristics with the help of suitable recording instruments:

- (i) Force Vs frequency
- (ii) Phase angle Vs frequency
- (iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the aeolian vibration frequency-band between the lower and upper dangerous frequency, limits determined by the vibration analysis of conductor without dampers.

Acceptance criteria for vibration damper.

- (i) The above dynamic characteristics test on five dampers shall be conducted.
- (ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

- (iii) The above mean reactance response curve should lie within following limits:

For ACSR Zebra equivalent HTLS Conductor: $0.135 f$ to $0.54 f$ Kgf/mm, where f is frequency in Hz.

For ACSR Panther equivalent HTLS Conductor: $0.0991 f$ to $0.495 f$, where f is frequency in Hz.

- (iv) The above mean phase angle response curve shall be between 25° to 130° within the frequency range of interest.
- (v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
- (vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the HTLS conductor shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be considered for the purpose of analysis: -

- (i) The analysis shall be done for single conductor without armour rods as per the parameters given under clause 2.5.13 of this part of the Specification. The tension corresponding to 25% of UTS of the HTLS conductor shall be taken for a span ranging from 100 m to 1100.
- (ii) The self-damping factor and flexural stiffness (EI) for HTLS conductor shall be calculated on the basis of experimental results. The details for experimental analysis with these data should be furnished.
- (iii) The power dissipation curve obtained from Dynamic Characteristics Test shall be used for analysis with damper.
- (iv) Examine the aeolian vibration level of the conductor with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
- (v) From vibration analysis of conductor without damper, anti-node vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

- (vi) From vibration analysis of conductor with damper/ dampers installed at the recommended location, the dynamic strain level, at the clamped span extremities, damper attachment points and the antinodes on the conductor shall be determined. In addition to above damper clamp vibration amplitude and anti-node vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

- (c) Clamp Slip and Fatigue Tests

- (i) Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 25% of UTS of the HTLS conductor. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U-bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

- (ii) Clamp Slip test

The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

(iii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than $\pm 25/f$ mm, where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the, test if resonance shift is observed the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned hereinabove shall be repeated after fatigue test without re-torquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from conductor and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristic of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The conductor under clamp shall also be free from any damage.

For the purpose of acceptance, the following criteria shall be applied.

- (1) There shall not be any frequency shift by more than ± 2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.
- (2) The force response curve shall generally lie within guaranteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Contractor.

- (3) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Contractor. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

2.4 Spacer/ Spacer Damper

(a) Vibration Tests (for Spacer Damper only)

The clamp slip tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The spacer damper assembly shall be clamped to conductor. The conductor shall be tensioned at tension corresponding to 25% of UTS of the HTLS conductor and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

During the vibration tests the axis of the clamp of sample shall be maintained parallel to its initial static position by applying a tension corresponding to 25% of UTS of the HTLS conductor. The spacer/ spacer damper assembly shall be free to vibrate and shall not be re-torqued or adjusted between the tests.

All the vibration tests mentioned hereunder shall be conducted on the same sample on the same test span. The samples shall withstand the vibration tests without slipping on the conductor, loosening, damage or failure of component parts. After each vibration test, clamp slip test shall be carried out as per the procedure given in Clause No 2.2 (b) below:

(i) Longitudinal Vibration Test

The stationary conductor and the vibrating conductor/equivalent diameter of aluminium alloy tube shall be restrained by fixed clamps. The displacement of the vibrating conductor shall be 25 mm minimum

on either side. The longitudinal movement shall be parallel to the conductor at frequency not less than 2 Hz for minimum one million cycles.

(ii) Vertical Vibration Test

The spacer/spacer damper shall be installed in the middle of the test span and the frequency chosen so as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimen to allow free movement of the conductor close to the test specimen. One conductor shall be connected to the shaker and vibrated to an amplitude such that.

$$f^{1.8} Y_{\max} > 1000 \text{ mm/sec.}$$

Where Y_{\max} being the antinode displacement (mm) and f is the test frequency (Hz). The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 million.

(iii) Sub-span Oscillation Test

The test shall be conducted for oscillation in horizontal plane at frequency higher than 3 Hz for minimum one million cycles. The amplitude for oscillation shall be kept equivalent to an amplitude of 150 mm for a full sub-span of 80m. Both the conductor shall be vibrated 180 deg. out of phase with the above minimum amplitude.

b) Clamp Slip Test

The spacer assembly shall be installed on test span of twin conductor bundle string at a tension corresponding to 25% of UTS of the conductor. In case of spacer for jumper, the clamp of sample shall be tightened with a specified tightening torque. One of the sample clamps, when subjected to a longitudinal pull parallel to the conductor axis for a minimum duration of one minute, shall not slip on the conductor i.e. the permanent displacement between the conductor and the clamp of the sample measured after removal of the load shall not exceed specified values. The minimum slip under longitudinal pull varies with clamp type according to the following table:

Clamp Type	Longitudinal Load (kN)	Maximum Slip (mm)
Metal-Metal bolted	6.5	1
Rubber loaded	2.5	2.5
Clamp using Preformed rods	2.5	12

c) Compressive and tensile test

This test shall be conducted on 3 (three) nos samples. The spacer assembly shall withstand ultimate compressive load of 14 kN and tensile load of 7.0 kN applied between sub-conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The centre line distance under load shall be within ± 100 mm of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight hand pressure. There shall be no deformation or damage to the spacer assembly which would impair its function of maintaining the normal spacing.

d) Dynamic Characteristic Test (for Spacer Damper only)

The purpose of this test is to obtain quantitative information regarding the dynamic characteristics of the spacer damper. The values obtained during this test will serve as references to evaluate the behaviour of the same spacer damper under the fatigue test.

The test will consist in the application of sinusoidal movement of the spacer-damper articulation and measuring the force (F), displacement (X) and phase angle (ϕ) between these two, from these values, the stiffness (K) and the damping factor (n) will be calculated.

$$K = \frac{F}{X} \times \cos \phi; n = \tan \phi$$

The test frequency shall not be higher than 3 Hz. The test shall be performed at five different displacement amplitudes. The amplitudes shall be selected to reproduce 10, 20, 40, 60 and 90 percent of the maximum displacement permitted by the spacer-damper design.

The test shall be performed on three samples.

e) Fatigue Test (for Spacer Damper only)

The purpose of this test is to evaluate the capacity of the spacer damper to sustain without damage the cyclic movements which can be induced by vibrations.

The spacer damper articulation shall be subjected to cyclic motions for a total of 10 million cycles. The test frequency shall be between 2 and 3 Hz. The amplitude of motion shall be established on the following basis:

- the load applied on the spacer damper clamp shall not be less than ± 300 N.
- the clamp displacement under the applied load shall not be less than 60% of the maximum displacement permitted by the design.
- if the 300 N load generates movement exceeding the maximum permitted displacement, the load can be reduced to limit the movement to 95% of the maximum displacement.
- After the test, the sample shall be subjected to a second dynamic characteristic test. This test shall be performed at two amplitudes, 10% and 60% of the maximum displacement.
- The spacer damper shall show no signs of cracks or deterioration, loosening of bolts or abnormal wear.

The dynamic characteristics (k and n) shall not be less than 60% of the values measured before the fatigue test. The test shall be performed on three samples.

f) Log Decrement test (for spacer damper only)

The spacer damper assembly shall be mounted on test span of conductor bundle at a tension of 0 deg. C & no wind and ruling span of 400 m. The test span shall be instrumented to continuously monitor and record the horizontal motion of the sub-conductor in the sub-span between suspension point and the first sample.

The log decrement test shall be made with initial peak to peak amplitude of four to six times the conductor diameter in the middle of the sub-span being considered. The conductor shall be excited in a horizontal one loop per sub-span resonant mode with a slow and steady build up of amplitude that minimises harmonics and other distortions. After achieving a steady state motion, the conductor excitation shall be discontinued leaving the conductor undisturbed. The motion shall be recorded until it reduces to amplitude of half of the conductor diameter. The logarithmic (log) decrement shall be the value for a minimum reduction of 80 % in amplitude. The minimum acceptable log decrement average for five or more excitation shall be 0.04 based upon the following formula for decay.

$$\text{Log}_e \frac{A_n}{A_{n+1}} = \frac{1}{n} \text{Log}_e \frac{A_0}{A}$$

Where A_0 is the initial amplitude and A_n is the amplitude 'n' cycles later

2.5 Magnetic Power Loss Test

The test shall be carried out as per clause no. 12 of IEC 61284 considering 50Hz AC of various magnitude (in steps of 50A) within $\pm 200A$ of specified ampacity at designed maximum temperature of HTLS conductor. The average power loss of the sample shall be plotted for each value of current. The value of the loss corresponding to specified ampacity at designed maximum temperature of the HTLS conductor shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

2.6 Thermal Profile test

The fitting/ accessories under the test shall be installed on conductor and current shall be passed through the conductor to achieve steady state conductor temperature corresponding to the designed maximum temperature of the offered HTLS conductor. Temperature achieved in different components of fittings/ accessories shall then be measured. The temperature of the components shall be below the specified maximum allowable temperature of the materials of those components. Maximum allowable temperature for aluminium/ aluminium alloy components shall be limited to 93 Deg C.

2.7 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should not drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

2.8 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV rms line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS 731:1971.

2.9 Radio Interference Voltage Test (Dry)

Under the conditions as specified under (2.5) above, the sample shall have a radio interference voltage level below 1000 microvolts at one MHz when subjected to 50 Hz AC voltage of 305 kV rms line to ground under dry condition. The test procedure shall be in accordance with IS 8263.

2.10 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

2.11 Galvanising/ Electroplating Test

The test shall be carried out as per Clause no. 9.4 of IS 2486 (Part-1) except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS 209:1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

Annexure-B

Acceptance Tests

1. Mid Span Compression Joint

(a) Hardness Test

The Brinnel hardness at various points on the steel sleeve of HTLS conductor core and tension clamp shall be measured.

2. T-Connector

(a) Axial Tensile Load Test for Welded Portion

Same as clause 2.2 of Annexure-A.

3. Vibration Damper

(a) Verification of Resonance Frequencies

The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of ± 0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

(b) Clamp Slip Test

Same as Clause 2.4 (c) (ii) of Annexure - A.

(c) Strength of the Messenger Cable

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor

(d) Mass Pull off Test

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

(e) **Dynamic Characteristics Test**

The test will be performed as acceptance test with the procedure mentioned for type test with sampling mentioned below: -

- (i) 1 Sample for 1 000 Nos. & below
- (ii) 3 Samples for lot above 1 000 & up to 5000 nos.
- (iii) Additional 1 sample for every additional 1500 pieces above 5000.

The acceptance criteria will be as follows

- (i) The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of $0.18/d$ Hz to $1.4/d$ Hz (where d is conductor diameter in meter).
- (ii) If all the individual curves for dampers are within the envelope as already mentioned for type test for reactance & phase angle, the lot passes the test.
- (iii) If individual results do not fall within the envelope, averaging of characteristics shall be done.
 - (a) Force of each damper corresponding to particular frequency shall be taken & average force of three dampers at the frequency calculated.
 - (b) Similar averaging shall be done for phase angle.
 - (c) Average force Vs frequency and average phase Vs frequency curves shall be plotted on graph paper. Curves of best fit shall be drawn for the entire frequency range.
 - (d) The above curves shall be within the envelope specified.

4. **Spacer/ Spacer Damper**

(a) **Test Set up**

The test set up for the test described hereunder shall be as per clause 2.2 (a) of Annexure-A.

(b) **Compressive and Tensile Test**

The spacer assembly shall withstand ultimate compressive load of 14 kN and tensile load of 7.0 kN applied between sub-conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The centre line distance under load shall be within ± 100 mm of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight

hand pressure. There shall be no deformation or damage to the spacer assembly which would impair its function of maintaining the normal spacing.

(c) **Clamp Slip Test**

Same as clause 2.2(b) of Annexure-A.

(d) **Hardness test for Elastomer**

The shore hardness at different points on the elastomer surface of cushion grip clamp shall be measured by shore hardness meter. It shall lie between 65 to 80.

(e) **UTS of Retaining Rods**

The ultimate tensile strength of the retaining rods shall be measured. The value shall not be less than 35 kg/mm².

SECTION-VIIA

CONDUCTOR

TECHNICAL SPECIFICATIONS

SECTION-VIIA

CONDUCTOR

Revision History

Revision No.	Date	Clause Ref	Description
Rev-0	June'2021		First Release
Rev-1	Oct'2021		First Revision
Rev-2	Jan'2022		Second Revision
Rev-3	Dec'2023		Third Revision

TECHNICAL SPECIFICATIONS

SECTION-VIIA

CONDUCTOR

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TECHNICAL SPECIFICATIONS

SECTION-VIIA

CONDUCTOR

1. Technical Description of Conductor

1.1 Details of Conductor

1.1.1 The Conductor shall generally conform to IS 398 (relevant part) except where otherwise specified herein.

1.1.2 Standard Technical Particulars

The Standard Technical Particulars (STP) of the ACSR, AACSR, AAAC and AL59 conductors are enclosed at Annexure-B1, B2, B3 and B4 respectively of this section. The values indicated in the STP are the minimum and/or maximum values required to be met by the supplier.

1.2 Workmanship

1.2.1 All the aluminium/ aluminium alloy and/or steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

1.2.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

1.2.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the STP for ACSR/ AACSR conductors. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand number of dips in Standard Preece test as indicated in STP. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IS 398 (relevant part) except where otherwise specified herein.

1.2.4 The steel strands shall be pre-formed and post formed in order to prevent spreading of strands in the event of cutting of complete core. Care shall be

taken to avoid, damages to galvanisation during pre-forming and post-forming operation.

1.3 Joints in Wires

1.3.1 Aluminium / Aluminium alloy Wires

1.3.1.1 During stranding, no aluminium/ aluminium alloy wire welds shall be made for the purpose of achieving the required conductor length.

1.3.1.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

1.3.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand as per STP.

1.3.2 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

1.4 Tolerances

The manufacturing tolerances to the extent indicated in the STP shall be permitted in the diameter of individual aluminium/ Aluminium alloy and steel strands and lay-ratio of the conductor.

1.5 Materials

1.5.1 Aluminium for ACSR Conductor

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IS 398 (relevant part) except where otherwise specified herein.

1.5.2 Aluminium Alloy for AAAC and AACSR Conductor

The aluminium alloy strands shall be hard drawn from heat treated aluminium alloy redraw rods confirming to type B as per the values indicated in the STP.

They shall have the same properties and characteristics as prescribed in IS 398 (relevant part) except where otherwise specified herein.

The strands shall be of Aluminium–Magnesium–Silicon alloy of electrical conductivity of minimum 53% IACS. The Aluminium alloy wires shall be subjected to artificial aging (precipitation treatment) in order to attain the specified tensile properties and conductivity.

1.5.3 Aluminium Alloy for AL59 Conductor

The wire material shall be an aluminium alloy meeting the requirements as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IS 398 (relevant part) except where otherwise specified herein.

1.5.4 Steel for ACSR and AACSR Conductors

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in as prescribed in IS 398 (relevant part) except where otherwise specified herein.

1.5.5 Zinc

The zinc used for galvanizing shall be electrolytic High-Grade Zinc of purity as indicated in the STP. It shall conform to and satisfy all the requirements of IS 209.

1.6 Standard Length

1.6.1 The standard length of the conductor shall be as indicated in the STP. All lengths outside this limit of tolerance shall be treated as random lengths. Not less than 90% of the total quantity of the conductor shall be supplied in standard lengths.

1.6.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered. At any point, the cumulative quantity supplied of 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 except for one last drum, which may be supplied with any random length necessary to complete the supply of ordered conductor quantity.

1.6.3 However, for AACSR type conductor meant for special crossings, the same shall be manufactured & supplied keeping in view tower schedules, section lengths, special crossings etc. and the drum schedules shall be submitted to Employer for review & approval.

1.6.4 The purchaser reserves the right to place orders for the lengths above the standard length on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

2.0 Tests and Standards

2.1 Type Tests

The following tests shall be conducted on sample/ sample(s) of the conductor required under the package from manufacturing works from which the conductor is to be manufactured & supplied: -

a)	DC resistance test on stranded conductor	Annexure-A
b)	UTS test on stranded conductor	
c)	Corona extinction voltage test (dry) <i>(Applicable for 220 kV or above voltage level only)</i>	
d)	Radio interference voltage test (dry) <i>(Applicable for 220 kV or above voltage level only)</i>	

2.1.1 Type tests specified under Clause 2.1 shall not be required to be carried out if supplier has conducted these tests earlier on the same conductor & same bundle configuration (applicable for tests 'c' & 'd') and valid type test certificates are available. The test certificate shall be considered valid if,

- Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/ IEC vide 25/ 17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and
- Type test reports contain valid Calibration reports of the relevant testing equipment and information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/relevant standards (IS/ IEC) and compliance to the same and

- iii) Tests conducted on the samples of conductor manufactured from same manufacturing works within 10 (ten) years as on the date of NOA for the package.

Further, test certificates of samples manufactured from same manufacturing works shall also be considered valid, if the same has already been approved/ accepted by POWERGRID & tests have been conducted within the abovementioned validity period.

In case the tests have been conducted earlier than the above stipulated period or carried out on samples manufactured from any other manufacturing works or in case of revision/ amendment in the provisions/ test procedure of the IS/ IEC as referred in the TS or in the event of any discrepancy in the test report (i.e. due to non-inclusion of valid calibration certificate, desired information etc. or any test 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 Specifications), the tests shall be conducted by the supplier at no extra cost to the purchaser.

2.2

Acceptance Tests

a)	Visual and dimensional check on drum	Annexure-A
b)	Visual check for joints, scratches etc. and length measurement of conductor by rewinding	
c)	Measurement of diameters of individual Steel and Aluminium strands	
d)	Check for lay-ratios of various layers	
e)	Galvanizing test on steel strands	
f)	Torsion and Elongation tests on steel strands	
g)	Breaking load test on steel and Aluminium strands	IS 398 (Part 2 or Part 5 as applicable)
h)	Breaking load test & Elongation test on Aluminium Alloy strands	IS 398 (Part 4 or Part 6 as applicable)
i)	Wrap test on Steel & Aluminium strands	IS 398 (Part 2 or Part 5 as applicable)
j)	Wrap test on Aluminium Alloy strands	IS 398 (Part 4 or part 6 as applicable)
k)	DC resistance test on Aluminium strands	Annexure-A
l)	DC resistance test on Aluminium Alloy strands of AAAC/ AACSR conductor	Annexure-A

m)	Resistivity Test on Aluminium Alloy strands of Al59 conductor	IS 398 (Part 6)
n)	Procedure qualification test on welded joint of Aluminium/ Aluminium Alloy strands	Annexure-A
o)	Drum strength test (steel drum)	Annexure-A
p)	Barrel Batten strength test (wooden drum)	Annexure-A
q)	UTS test on stranded conductor	Annexure-A
r)	DC Resistance test on stranded conductor	Annexure-A

Note:

1. All the above tests except (n) shall be carried out on Aluminium and steel strands after stranding only.
2. The tests mentioned at (q) & (r) above shall be carried out after every 3 years for each stranding machine from which samples are offered. These tests shall however, not be required to be carried out till 3 years from the date of type testing for the stranding machine for which valid test certificates are available

2.2.1

The acceptance tests pertaining to conductor only shall be repeated on one conductor sample taken from site in presence of POWERGRID's representative once under a package for each conductor manufacturer having more than 500 km conductor supply. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by POWERGRID's site representative and the tests shall be witnessed by POWERGRID's QA&I representative. In case of evidence of non-compliance, it shall be binding on the part of the supplier to prove compliance of the items to the technical specification by repeat tests, or correction of deficiencies, or replacement of defective items all, without any extra cost to the purchaser.

2.3

Routine Test

a)	Check to ensure that the joints are as per Specification
b)	Check that there are no cuts, fins etc. on the strands
c)	Check that drums are as per Specification
d)	All acceptance test as mentioned above to be carried out on aluminium/ aluminium alloy and steel strands of 20% of drums

2.4

Tests During Manufacture

a)	Chemical analysis of zinc used for galvanizing	Annexure-A
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b)	Chemical analysis of Aluminium used for making Aluminium/ Aluminium alloy strands	
c)	Chemical analysis of steel used for making steel strands	

2.5 Testing Expenses

2.5.1 In the event of type testing, bidder shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule.

2.5.2 In case of failure in any type test, the supplier is either required to manufacture fresh sample lot and repeat the entire tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expense. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

If repeat type tests are required to be conducted, then all the expenses for deputation of inspector/purchaser's representative shall be to the supplier's account. Also, if on receipt of the supplier's notice of testing, the purchaser's representative does not find the test samples or testing facilities/equipment ready for testing, the expenses incurred by the purchaser for re-deputation shall be to the supplier's account.

2.5.3 The Contractor shall intimate the Employer about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of testing in India) and at least 6 weeks in advance (in case of testing abroad) of the schedule date of testing during which the Employer will arrange to depute his representative to be present at the time of carrying out the tests.

2.5.4 The entire cost of testing for the type, acceptance, routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/purchaser's representative.

2.6 Additional Tests

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

2.6.2 The purchaser also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at supplier's premises or at any other test center. In case of evidence of non-

compliance, it shall be binding on the part of supplier to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the purchaser.

2.7 Sample Batch for Type Testing

- 2.7.1 In case the type tests are required to be carried out, the samples for type testing shall be manufactured in accordance with the Standard Manufacturing Quality Plan.
- 2.7.2 The supplier shall offer at least three drums for selection of sample required for conducting all the type tests.
- 2.7.3 The supplier is required to carry out all the acceptance tests successfully in presence of purchaser's representative before sample selection.

2.8 Test Reports

- 2.8.1 In case type tests have been carried out earlier by the supplier and valid type test reports are available as specified in clause 2.1.1 above, the supplier shall submit one copy of the test report along with approval letter issued by POWERGRID or utility.
- 2.8.2 In case fresh type tests have been carried out under the package, the type test reports shall be furnished in original along with two copies. One copy will be returned duly certified by the purchaser.
- 2.8.2 The commercial production of the conductor can be taken up by the supplier after clearance from the purchaser.
- 2.8.3 Record of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser's representative.
- 2.8.4 Test Certificates of tests during manufacture shall be maintained by the supplier. These shall be produced for verification as and when desired by the purchaser.

2.9 Inspection

- 2.9.1 The purchaser's 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 supplier's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

- 2.9.2 The supplier shall keep the purchaser 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.
- 2.9.3 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 purchaser in writing. In the latter case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.
- 2.9.4 The acceptance of any quantity of material shall in no way absolve the supplier 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.

2.10 Test Facilities

- 2.10.1 The following test facilities shall be available at the supplier's works:
- a) Various testing and measuring equipment for carrying out specified acceptance tests, routine tests and tests during manufacture inter alia including tensile testing machine, resistance measurement facilities, torsion & wrap testing machine, dimension checking instruments viz. digital Vernier and micrometer etc., galvanizing test instruments viz. digital electrometer and standard preece test etc., burette, digital thermometer, barometer etc.
 - b) Digital mili/micro ohm meter along with standard resistance for calibration of resistance bridges.
 - c) Spectrometer, if supplier has its own properzi mill
 - 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.

2.11 Packing

- 2.11.1 The conductor shall be supplied in returnable, painted steel drums of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

- 2.11.2 One standard length shall be wound on each drum. The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.
- 2.11.3 The standard drawing of the drum for ACSR, AAAC and AL59 types of conductors is enclosed with the specification. The Bidder shall supply the conductor in the drum conforming to the specification drawing. After preparation of steel surface according to IS 9954, synthetic enamel paint shall be applied after application of one coat of primer.
- 2.11.4 The ownership of the empty conductor drums shall lie with the conductor supplier who shall ultimately take back the empty conductor drums from the erection contractor's designated stores at project site(s) after the running out of conductor from the drums.
- 2.11.5 The erection contractor shall intimate the conductor supplier and employer regarding empty steel drums at their designated stores. Necessary coordination for taking back the empty steel drums in this regard shall be done by the conductor supplier with the erection contractor.
- 2.11.6 The empty drums shall be taken back by the conductor supplier from the stores of erection contractor as & when these are available after usage of conductor. Conductor supplier shall be required to take back the empty steel drum within a period of one month from date of information by erection contractor regarding availability of the drums at erection contractor stores. However, drums of spare conductor shall not be returned to the conductor supplier as these may be used for storage of spare conductor by the purchaser.
- 2.11.7 The steel drums may get damaged and/ or wear & tear during transportation, normal handling & operation at site, which shall be rectified by the conductor supplier before re-use. However, 2% of the total drums shall not be returned on account of damages/ wastage for which no compensation will be payable. The wastage beyond 2% shall be reimbursed by erection contractor.
- 2.11.8 Solid Polypropylene sheet of minimum 3mm thickness shall be used for outer covering of conductor. Outside the covering, there shall be minimum two binders consisting of hoop iron/ galvanised steel wire. Two numbers of additional binders per drum shall also be supplied for re-wrapping the polypropylene sheet with each lot of conductor and 5 nos. crimping machines with the first lot of conductor for crimping the binders at site. As an alternative, supplier may use wooden lagging of minimum 50 mm thickness for outer covering of conductor without any extra financial implication to the purchaser.

- 2.11.9 As an alternative to returnable steel drum, bidder may supply the conductor in non-returnable wooden drums. However, for bid evaluation purpose, both types of drums shall be treated at par and bidder may quote accordingly.
- 2.11.10 The standard drawing of the wooden drum for ACSR, AAAC and AL59 types of conductors is also enclosed with the specification. The Bidder shall supply the conductor in the drum conforming to the specification drawing.
- 2.11.11 The wooden drums shall generally conform to IS 1778, except as otherwise specified hereinafter. All wooden components shall be manufactured out of seasoned soft wood, free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor. 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. Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. 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.
- 2.11.12 Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material over which HDPE sheet to be provided. In case of steel drum, for securing HDPE sheet onto the bamboo paper & drum flanges, the HDPE sheet shall be secured onto the drum by means of a commercial adhesive/self-locking nylon cable zip ties such that there is no protrusion above the general surface that may cause damage to the conductor strands. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thick plastic sheet secured using adhesive tapes to preserve the conductor from ingress of water, dirt, grit and damages during storage, transport and handling. Medium grade craft/crepe/polythene paper shall be used in between the layers of conductor.
- 2.11.13 The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.
- 2.12 Marking**
- Each drum shall have the following information stenciled on it in indelible ink along with other essential data:
- (a) Contract/Specification number.

- (b) Name and address of the consignee.
- (c) Manufacturer's name and address.
- (d) Drum number
- (e) Size of conductor
- (f) Length of conductor in meters
- (g) Arrow marking for unwinding
- (h) Position of the conductor end (For Wooden Drums only)
- (i) Number of turns in the outer most layer.
- (j) Gross weight of the drum (with protective lagging in case of wooden drums) including conductor.
- (k) Weight of empty drum (with protective lagging in case of wooden drums).
- (l) Net weight of the conductor in the drum.
- (m) CIP No.

The above should be indicated in the packing list also. To accommodate the above details, conductor manufacturer may suitably design the plate size larger than that specified in the standard drum drawing, if required.

2.13 Verification of Conductor Length

The purchaser reserves the right to verify the length of conductor after unreeling. The quantity for verification shall be between a minimum of five percent (5%) to a maximum of ten percent (10%) in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the supplier & purchaser.

2.14 Standards

2.14.1 The conductor shall conform to the following Indian Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

2.14.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the supplier and those specified in this document will be provided by the supplier to establish their equivalence.

Sl. No.	Indian Standard	Title
1	IS 209	Specification for zinc
2	IS 398 (Part 1)	Specification for Aluminium Conductors for Overhead Transmission Purposes
3	IS 398 (Part 2)	Aluminum Conductor Galvanised Steel Reinforced
3	IS 398 (Part 4)	All Aluminum Alloy Conductor
4	IS 398 (Part 5)	Aluminum Conductor Galvanised Steel-Reinforced for Extra High Voltage (400 KV) and above
5	IS 398 (Part 6)	Aluminium Conductors for Overhead Transmission Purposes High Conductivity Aluminum Alloy Stranded Conductors —Specification
6	IS 1778	Reels and Drums for Bare Conductors
7	IS 1521	Method of Tensile Testing of Steel Wire
8	IS 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
9	IS 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
10	IS 4826	Galvanised Coating on Round Steel Wires
11	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and steel articles
12	IS 8263	Method of Radio Interference Tests on High Voltage Insulators

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BIS/IS	Bureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001 INDIA

Annexure-A

1 DC Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or digital ohm-metre of sufficient accuracy by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per IS 398. The test results shall conform to the requirements specified in the STP.

2 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 between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS 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 steady rate to 100% of the UTS of conductor and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and this value shall be recorded.

3 Corona Extinction Voltage Test

The sample assembly with each conductor of 5 m length shall be strung as per the configuration shown in the Table below:

Line Configuration	No of conductors per Bundle	Sub-conductor Spacing (mm)	Maximum Height of the conductor above ground (m)	Minimum Corona extinction voltage (kV)
220 kV	1	NA	7	154
400 kV with twin bundle conductor	2	450	8.84	320
400 kV with Triple bundle conductor	3	457	8.84	320
400 kV with Quad bundle conductor	4	457	8.84	320
765 kV with Quad bundle conductor	4	457	15	510
765 kV with Hexa bundle conductor	6	457	15	510

± 500 kV HVDC Bipole line with Quad bundle conductor	4	457	12.5 *	550
± 800 kV HVDC Bipole line with Hexa bundle conductor	6	457	18 *	880

* Height shall be suitably adjusted so as to achieve a surface gradient of 22 kV/cm on the conductors.

The sample assembly when subjected to power frequency/dc voltage under dry condition shall have a corona extinction voltage of not less than the values indicated in the table above. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The atmospheric conditions during testing shall be recorded and test results should be corrected for standard atmospheric conditions.

4 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage below 1000 microvolts at one MHz when subjected to 50HZ AC Voltage (line to ground under dry conditions) as per following table:

Line Voltage	Applicable Voltage for RIV test (kV)
220 kV	154
400 kV	305
765 kV	510
± 500 kV HVDC Bipole line with Quad bundle conductor	550
± 800 kV HVDC Bipole line with Hexa bundle conductor	880

This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-60437.

5 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

6 Visual Check for Joints, Scratches etc. and length measurement of conductor by rewinding

Conductor drums shall be rewound in the presence of the Employer. The Employer shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification.

7 Measurement of diameters of individual Steel and Aluminium/ Aluminium alloy strands

The diameters of the individual strands shall be checked to ensure that they conform to the requirement of this Specification.

8 Check for Lay-ratios of Various Layers

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

9 Galvanizing Test

The test procedure shall be as specified in IS 398. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

10 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per IS 398. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the STP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand, for a gauge length of 250 mm after stranding, shall not be less than the value specified in STP.

11 DC resistance test on Aluminium strands

DC resistance test on individual strands (after stranding) shall be done as per test procedure specified in IS 398 (part 2 or part 5 as applicable). The measured resistance value corrected at 20°C shall conform to the value specified in STP.

12 DC resistance test on Aluminium Alloy strands of AAAC/ AACSR conductor

DC resistance test on individual strands (after stranding) shall be done as per test procedure specified in IS 398 (part 4). The measured resistance value corrected at 20°C shall conform to the value specified in STP.

13 Procedure Qualification test on welded Aluminium/ Aluminium alloy

Two Aluminium/ Aluminium alloy wire shall be welded as per the standard quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

14 Drum Strength Test (Steel Drum)

The test shall be conducted as per IS 15976 once on one drum for each package with one standard length of conductor wound on the drum during first lot offered for inspection.

15 Barrel Batten Strength Test (Wooden Drum)

The test shall be conducted as per IS 1778 on one drum of each lot offered for inspection. Barrel batten strength shall not be less than 300 Kg.

16 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

17 Chemical Analysis of Aluminium/ Aluminium Alloy

Samples taken from the aluminium/ Aluminium alloy ingots/rods shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

18 Chemical Analysis of Steel

Samples taken from the steel rods shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

Standard Technical Particulars for ACSR Conductors

Sl. No.	Description	Unit	Standard Technical Particulars					
			ACSR LAPWING	ACSR BERSIMIS	ACSR SNOWBIRD	ACSR MOOSE	ACSR ZEBRA	ACSR PANTHER
1.0	Construction							
1.1	Stranding and wire diameter							
a)	Aluminium wire		45/4.78 mm	42/4.57 mm	42/3.99 mm	54/3.53 mm	54/3.18 mm	30/3.00 mm
b)	Steel wire		7/3.18 mm	7/2.54 mm	7/2.21 mm	7/3.53 mm	7/3.18 mm	7/3.00 mm
1.2	Layer & no. of wire							
a)	Steel core		1	1	1	1	1	1
b)	1 st steel layer		6	6	6	6	6	6
c)	1 st Aluminium alloy layer		9	8	8	12	12	12
d)	2 nd Aluminium alloy layer		15	14	14	18	18	18
e)	3 rd Aluminum alloy layer		21	20	20	24	24	NA
2.0	Raw Materials							
2.1	Aluminium							
a)	Minimum purity of Aluminium	%	99.50					
b)	Maximum copper content	%	0.04					
2.2	Steel wires/ rods							
a)	Carbon	%	0.50 to 0.85					

Sl. No.	Description	Unit	Standard Technical Particulars					
			ACSR LAPWING	ACSR BERSIMIS	ACSR SNOWBIRD	ACSR MOOSE	ACSR ZEBRA	ACSR PANTHER
b)	Manganese	%	0.50 to 1.10					
c)	Phosphorous	%	Not more than 0.035					
d)	Sulphur	%	Not more than 0.045					
e)	Silicon	%	0.10 to 0.35 (Max.)					
2.3	Zinc							
a)	Minimum purity of Zinc	%	99.95					
3.0	Aluminum strands after stranding							
3.1	Diameter							
a)	Nominal	mm	4.78	4.57	3.99	3.53	3.18	3.00
b)	Maximum	mm	4.81	4.60	4.02	3.55	3.20	3.02
c)	Minimum	mm	4.75	4.54	3.96	3.51	3.16	2.98
3.2	Minimum breaking load of strand							
a)	Before stranding	KN	2.87	2.64	2.12	1.57	1.29	1.17
b)	After stranding	KN	2.73	2.51	2.02	1.49	1.23	1.11
3.3	Max. resistance of 1 m length of strand at 20°C	Ohm	0.001595	0.001746	0.002295	0.002921	0.003604	0.004053
4.0	Steel strand after stranding							
4.1	Diameter							
a)	Nominal	mm	3.18	2.54	2.21	3.53	3.18	3.00

Sl. No.	Description	Unit	Standard Technical Particulars					
			ACSR LAPWING	ACSR BERSIMIS	ACSR SNOWBIRD	ACSR MOOSE	ACSR ZEBRA	ACSR PANTHER
b)	Maximum	mm	3.24	2.59	2.25	3.59	3.24	3.06
c)	Minimum	mm	3.12	2.49	2.17	3.47	3.12	2.94
4.2	Minimum breaking load of strand							
a)	Before stranding	KN	10.43	6.87	4.74	12.86	10.43	9.29
b)	After stranding	KN	9.91	6.53	4.49	12.22	9.91	8.83
4.3	Galvanising							
a)	Minimum weight of zinc coating per sqm	gm	250	230	230	250	250	240
b)	Minimum number of dips that the galvanised strand can with stand in the standard preece test	Nos.	2 of one minute & 1 of half minute	2 of one minute	2 of one minute & 1 of half minute			
c)	Min. No. of twists in gauge length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16	16	16	16	16	16
d)	Min. elongation of the steel strand (after stranding) for a gauge length of 250 mm (after break)	%	3.5	3.5	3.5	3.5	3.5	3.5
5.0	Stranded Conductor							
5.1	Overall diameter	mm	38.22	35.04	30.57	31.77	28.62	21.00
5.2	Sectional area of Aluminium	sq. mm	807.5	688.9	525.2	528.5	428.9	212.1

Sl. No.	Description	Unit	Standard Technical Particulars											
			ACSR LAPWING		ACSR BERSIMIS		ACSR SNOWBIRD		ACSR MOOSE		ACSR ZEBRA		ACSR PANTHER	
5.3	Total sectional area	sq. mm	863.1		724.4		552.1		597.0		484.5		261.5	
5.4	Minimum UTS of the conductor	kN	188.0		154.0		118.0		161.20		130.32		89.67	
5.5	Lay ratio of outer steel & Aluminium layer		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
a)	1 st steel layer	mm	30	18	24	16	24	16	18	16	18	13	28	16
b)	1 st Aluminium layer	mm	17	10	16	10	16	10	14	12	17	10	16	10
c)	2 nd Aluminium layer	mm	16	10	16	10	16	10	13	11	16	10	14	10
d)	3 rd Aluminum layer	mm	13	10	13	10	14	10	12	10	14	10	NA	NA
5.6	Maximum DC resistance of the conductor at 20°C	ohm/km	0.0358		0.04242		0.05516		0.05552		0.06868		0.1390	
5.7	Standard length of the conductor	m	1800		2100		2600		2400		3000		3500	
5.8	Tolerance on Standard length	%	± 5											
5.9	Direction of lay of outer layer		Right Hand											
5.10	Linear mass of the conductor													
a)	Standard	kg/km	2667		2181		1657		2004		1621		974	
b)	Minimum	kg/km	2628		2142		1632		1969		1589		954	
	Maximum	kg/km	2707		2221		1682		2040		1653		993	

Standard Technical Particulars for AACSR Conductors

Sl. No.	Description	Unit	Standard Technical Particulars					
			AACSR LAPWING	AACSR BERSIMIS	AACSR SNOWBIRD	AACSR MOOSE	AACSR ZEBRA	AACSR Earthwire
1.0	Construction							
1.1	Stranding and wire diameter							
a)	Aluminium Alloy wire		45/4.78 mm	42/4.57 mm	42/3.99 mm	54/3.53 mm	54/3.18 mm	16/2.86 mm
b)	Steel wire		7/3.18 mm	7/2.54 mm	7/2.21 mm	7/3.53 mm	7/3.18 mm	19/2.48 mm
1.2	Layer & no. of wire							
a)	Steel core		1	1	1	1	1	1
b)	1 st steel layer		6	6	6	6	6	6
c)	2 nd steel layer		NA	NA	NA	NA	NA	12
d)	1 st Aluminium alloy layer		9	8	8	12	12	16
e)	2 nd Aluminium alloy layer		15	14	14	18	18	NA
f)	3 rd Aluminum alloy layer		21	20	20	24	24	NA
2.0	Raw Materials							
2.1	Aluminium alloy							
a)	Silicon	%	0.50-0.90					

STANDARD SPECIFICATION OF TRANSMISSION LINE
(SECTION-CONDUCTOR)



Sl. No.	Description	Unit	Standard Technical Particulars					
			AACSR LAPWING	AACSR BERSIMIS	AACSR SNOWBIRD	AACSR MOOSE	AACSR ZEBRA	AACSR Earthwire
b)	Magnesium	%	0.60-0.90					
c)	Iron	%	0.50 (Max)					
d)	Copper	%	0.10 (Max)					
e)	Manganese	%	0.03 (Max)					
f)	Chromium	%	0.03 (Max)					
g)	Zinc	%	0.10 (Max)					
h)	Boron	%	0.06 (Max)					
i)	Other element (each)	%	0.03 (Max)					
j)	Other element (Total)	%	0.10 (Max)					
k)	Aluminium	%	Remainder					
2.2	Steel wire/ rod							
a)	Carbon	%	0.50-0.85					
b)	Manganese	%	0.50-1.10					
c)	Phosphorous	%	Not more than 0.035					
d)	Sulphur	%	Not more than 0.045					
e)	Silicon	%	0.10 to 0.35 (Max.)					
2.3	Zinc							
a)	Minimum purity of Zinc	.%	99.95					
3.0	Aluminum alloy strands after stranding							

Sl. No.	Description	Unit	Standard Technical Particulars					
			AACSR LAPWING	AACSR BERSIMIS	AACSR SNOWBIRD	AACSR MOOSE	AACSR ZEBRA	AACSR Earthwire
3.1	Diameter							
a)	Nominal	mm	4.78	4.57	3.99	3.53	3.18	2.86
b)	Maximum	mm	4.81	4.61	4.03	3.55	3.20	2.89
c)	Minimum	mm	4.75	4.53	3.95	3.51	3.16	2.83
3.2	Minimum breaking load of strand							
a)	Before stranding	KN	5.54	5.07	3.88	3.02	2.46	1.98
b)	After stranding	KN	5.27	4.82	3.68	2.87	2.34	1.88
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.001868	0.002034	0.00265	0.003388	0.004175	0.005167
4.0	Steel strands after stranding							
4.1	Diameter							
a)	Nominal	mm	3.18	2.54	2.21	3.53	3.18	2.48
b)	Maximum	mm	3.24	2.57	2.25	3.59	3.24	2.53
c)	Minimum	mm	3.12	2.51	2.17	3.49	3.12	2.43
4.2	Minimum breaking load of strand							
a)	Before stranding	KN	10.43	6.87	5.04	12.86	10.43	6.63
b)	After stranding	KN	9.91	6.53	4.79	12.22	9.91	6.30
4.3	Galvanising							

Sl. No.	Description	Unit	Standard Technical Particulars													
			AACSR LAPWING		AACSR BERSIMIS		AACSR SNOWBIRD		AACSR MOOSE		AACSR ZEBRA		AACSR Earthwire			
a)	Minimum weight of zinc coating per sqm.	gm	250		220		230		250		240		220			
b)	Minimum number of dips that the galvanised strand can with stand in the standard preece test	Nos.	2 of one minute & 1 of half minute		2 of one minute		2 of one minute & 1 of half minute						2 of one minute			
c)	Min. No. of twists in gauge length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16													
d)	Min. elongation of the steel strand (after stranding) for a gauge length of 250 mm (after break)	%	3.5													
5.0	Stranded Conductor															
5.1	Overall diameter	mm	38.22		35.04		30.57		31.77		28.62		18.12			
5.2	Sectional area of Aluminium alloy	sq. mm	807.5		689.5		525.2		528.5		428.9		102.8			
5.3	Total sectional area	sq. mm	863.1		725.0		552.1		597.0		484.5		194.6			
5.4	Minimum UTS of the conductor	kN	289.1		232		178.2		224.64		181.5		143.22			
5.5	Lay ratio of outer steel & Aluminium alloy layer		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
a)	1 st Steel layer	mm	30	18	24	16	18	16	18	16	18	16	28	18		

STANDARD SPECIFICATION OF TRANSMISSION LINE
(SECTION-CONDUCTOR)



Sl. No.	Description	Unit	Standard Technical Particulars											
			AACSR LAPWING		AACSR BERSIMIS		AACSR SNOWBIRD		AACSR MOOSE		AACSR ZEBRA		AACSR Earthwire	
b)	2 nd Steel layer		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24	16
c)	1 st Aluminium alloy layer	mm	17	10	17	12	14	12	14	12	14	12	14	10
d)	2 nd Aluminium alloy layer	mm	16	10	16	10	13	11	13	11	13	11	NA	NA
e)	3 rd Aluminum alloy layer	mm	13	10	13	10	12	10	12	10	12	10	NA	NA
4.5	Maximum DC resistance of the conductor at 20°C	ohm/km	0.0414		0.0481		0.060		0.0624		0.07689		0.3291	
4.6	Direction of lay of outer layer		Right Hand											
4.7	Linear mass of the conductor													
a)	Standard	kg/km	2663		2181		1655		1996		1621		1005	
b)	Minimum	kg/km	2619		2142		1634		1963		1589		980	
c)	Maximum	kg/km	2708		2221		1684		2032		1653		1030	

Standard Technical Particulars for AAAC Conductors

Sl. No.	Description	Unit	Standard Technical Particulars		
			AAAC MOOSE	AAAC ZEBRA	AAAC PANTHER
1.0	Construction				
1.1	Stranding and wire diameter				
a)	Aluminium Alloy wire		61/3.55 mm	61/3.19 mm	37/3.15 mm
1.2	Layer & no. of wire				
a)	Aluminium alloy core		1	1	1
b)	1 st Aluminium alloy layer		6	6	6
c)	2 nd Aluminium alloy layer		12	12	12
d)	3 rd Aluminum alloy layer		18	18	18
e)	4 th Aluminium alloy layer		24	24	NA
2.0	Raw Materials				
2.1	Aluminium alloy				
a)	Silicon	%	0.50-0.90		
b)	Magnesium	%	0.60-0.90		
c)	Iron	%	0.50 (Max)		
d)	Copper	%	0.10 (Max)		
e)	Manganese	%	0.03 (Max)		
f)	Chromium	%	0.03 (Max)		
g)	Zinc	%	0.10 (Max)		
h)	Boron	%	0.06 (Max)		
i)	Other element (each)	%	0.03 (Max)		
j)	Other element (Total)	%	0.10 (Max)		
k)	Aluminium	%	Remainder		
3.0	Aluminum alloy strands after stranding				
3.1	Diameter				
a)	Nominal	mm	3.55	3.19	3.15
b)	Maximum	mm	3.59	3.22	3.18
c)	Minimum	mm	3.51	3.16	3.12
3.2	Minimum breaking load of strand				

Sl. No.	Description	Unit	Standard Technical Particulars					
			AAAC MOOSE		AAAC ZEBRA		AAAC PANTHER	
a)	Before stranding	KN	2.92		2.47		2.41	
b)	After stranding	KN	2.77		2.35		2.29	
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.003362		0.004103		0.00429	
4.0	Stranded Conductor							
4.1	Overall diameter	mm	31.95		28.71		22.05	
4.2	Total sectional area	sq. mm	604		487.5		288.3	
4.3	Minimum UTS of the conductor	kN	159.80		135.6		84.71	
4.4	Lay ratio of aluminium alloy layer		Max	Min	Max	Min	Max	Min
a)	1 st Aluminium alloy layer	mm	17	10	17	10	17	10
b)	2 nd Aluminium alloy layer	mm	16	10	16	10	16	10
c)	3 rd Aluminum alloy layer	mm	15	10	15	10	14	10
d)	4 th Aluminium alloy layer	mm	14	10	14	10	NA	NA
4.5	Maximum DC resistance of the conductor at 20°C	ohm/km	0.05506		0.06815		0.1182	
4.6	Standard length of the conductor	m	2400		3000		3500	
4.7	Tolerance on Standard length	%	± 5					
4.8	Direction of lay of outer layer		Right Hand					
4.9	Linear mass of the conductor							
a)	Standard	kg/km	1666		1345		795	
b)	Minimum	kg/km	1632		1318		778	
c)	Maximum	Kg/km	1699		1371		809	

Annexure-B4

Standard Technical Particulars for AL59 Conductors

Sl. No.	Description	Unit	Standard Technical Particulars					
			AL59 MOOSE		AL59 ZEBRA		AL59 PANTHER	
1.0	Construction							
1.1	Stranding and wire diameter							
a)	Aluminium Alloy wire		61/3.31 mm		61/3.08 mm		37/3.08 mm	
1.2	Layer & no. of wire							
a)	Aluminium alloy core		1		1		1	
b)	1 st Aluminium alloy layer		6		6		6	
c)	2 nd Aluminium alloy layer		12		12		12	
d)	3 rd Aluminum alloy layer		18		18		18	
e)	4 th Aluminium alloy layer		24		24		NA	
2.0	Aluminum alloy strands after stranding							
2.1	Diameter							
a)	Nominal	mm	3.31		3.08		3.08	
b)	Maximum	mm	3.34		3.11		3.11	
c)	Minimum	mm	3.28		3.05		3.05	
2.2	Minimum breaking load of strand							
a)	Before stranding	KN	2.15		1.86		1.86	
b)	After stranding	KN	2.04		1.77		1.77	
2.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.003376		0.003899		0.003899	
2.4	Minimum Elongation on 250 mm (Before & after stranding)	%	2		2		2	
3.0	Stranded Conductor							
3.1	Overall diameter	mm	29.79		27.72		21.56	
3.2	Total sectional area	sq. mm	525		454		276	
3.3	Minimum UTS of the conductor	kN	124.70		108.00		65.47	
3.4	Lay ratio of Aluminium alloy layer		Max	Min	Max	Min	Max	Min
a)	1 st Aluminium alloy layer	mm	17	10	17	10	17	10
b)	2 nd Aluminium alloy layer	mm	16	10	16	10	16	10
c)	3 rd Aluminum alloy layer	mm	15	10	15	10	14	10

Sl. No.	Description	Unit	Standard Technical Particulars					
			AL59 MOOSE		AL59 ZEBRA		AL59 PANTHER	
d)	4 th Aluminium alloy layer	mm	14	10	14	10	NA	NA
3.5	Maximum DC resistance of the conductor at 20°C	ohm/km	0.0566		0.0653		0.1075	
3.6	Standard length of the conductor	m	2400		3000		3500	
3.7	Tolerance on Standard length	%	± 5					
3.8	Direction of lay of outer layer		Right Hand					
3.9	Linear mass of the conductor							
a)	Standard	kg/km	1449		1254		759	
b)	Minimum	kg/km	1420		1229		744	
c)	Maximum	kg/km	1478		1279		774	

STANDARD MANUFACTURING QUALITY PLAN

FOR

ACSR AND AAC CONDUCTOR

Document No. (C/QA/SMQP/ACSR/AAC- Rev 00

(Valid From: 12.03.2020 to Validity as per respective MQP extension letter)



STANDARD MANUFACTURING QUALITY PLAN (SMQP) FOR MULTISTRAND ACSR & AAC CONDUCTOR
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Code 1	Indicates place where testing is planned to be performed i.e. Inspection location.	Code 2	Indicates who has to perform the tests i.e. Testing Agency
A	At conductor manufacturer's works	J	The Conductor Manufacturer
B	At Component manufacturer's works	K	The Component Manufacturer
C	At authorized distributors place	L	The Third Party
D	At independent Lab.	M	The Turn key Contractor
E	At turn key contractor's location		
F	Not Specified		

Code 3	Indicates who shall witness the tests i.e. Witnessing Agency	Code 4	Review of Test Reports/Certificates
P	Component Manufacturer	W	By conductor Manufacturer
Q	Component Manufacturer and conductor Manufacturer	X	By Contractor during product/process inspection
R	Component Manufacturer, Conductor Manufacturer and Contractor	Y	By POWERGRID during product/process inspection.
S	Conductor Manufacturer	Z	By Contractor and /or POWERGRID during product/process inspection.
T	Conductor Manufacturer and Contractor		
U	Conductor Manufacturer, and/or Contractor and POWERGRID		
V	Third Party		

Code 5	Whether specific approval of sub-vendor / component make envisaged?	Code 6	Whether test records required to be submitted after final inspection for issuance of CIP/MICC
E	Envisaged	Y	Yes
N	Not Envisaged	N	No

Component Manufacturer- Aluminium ingot/wire rod and galvanized steel wire supplier



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NOTES :

- 1 The MQP should be read in conjunction with the applicable technical specification against which the conductor is being manufactured.
- 2 In case of any contradiction between MQP and POWERGRID Technical specification, the Technical specifications of respective project shall have precedence over this MQP.
- 3 Proper co-relation of materials with test certificates from Raw Material stage to finished conductor shall be maintained.
- 4 The Aluminium Ingots/aluminium wire rods shall be procured from POWERGRID approved sources / LME registered manufacturers. Aluminium ingot to aluminium wire rod conversion from any conversion agent/ conductor manufacturer's own facility needs to be approved by POWERGRID. The conductor manufacturer shall furnish the test certificates of Aluminium ingot/wire rod for review by POWERGRID.
- 5 Galvanized Steel Wire to be procured from POWERGRID approved sources and the conductor manufacturer shall furnish the following test certificates from steel wire manufacturer for review by POWERGRID :
 - Chemical Test Certificate of Steel Wire Rod issued by its Manufacturer
 - Test Certificate of Zinc issued by its Manufacturer
 - Test certificates of the tests carried out by steel wire manufacturer on finished steel wire.

The conductor manufacturer shall obtain steel wire manufacturer's test certificates for galvanized steel wire for at least 20% of the coils and conductor manufacturer shall carry out tests on 10% of coils on receipt of steel wire.
- 6 Adequate care shall be taken to avoid damages to galvanised coating during preforming and post forming operations. Special care should be taken to keep away dirt, grit, etc during stranding.
- 7 Valid calibration certificates of various testing and measuring instrument / equipments from Labs accredited as per ISO/IEC -17025 which operates in accordance with the requirements of ISO/IEC 17011 having full membership & MRA of ILAC/APLAC. Standard resistance for verification of Resistance bridges must be available at conductor manufacturer works. Conductor manufacturer shall inform POWERGRID regional QA&I office regarding the date of calibration. POWERGRID representative shall witness the calibration of the testing equipments and after calibration, the testing equipments shall be sealed properly.
- 8 The area where conductor is to be manufactured (stranding m/c & rewinding m/c) shall be covered with rubber mat/ coir mat/ Wooden floor, etc.
- 9 All guides, rollers, pulleys etc. used for manufacturing conductor shall be of Nylon/ Hylum/ Teflon or other soft material instead of steel.
- 10 Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at variable speed from 8 to 16 mtr/ minute. The rewinding facilities shall have appropriate clutch system and shall be free from vibration and jerks etc. with traverse laying facilities. If conductor length is found less than the declared length during rewinding, then two drums from the same lot shall be verified for declared length. In case any of these drums are found having lesser length, the lot will be rejected and if these two drums' length matches the declared length, whole lot shall be accepted after deduction of length as observed for first case in rest of the drums. In case of defects in surface finish, additional two drums shall be taken for rewinding & if problem is observed, in any of the two drums the entire lot shall be rejected.
- 11 The conductor manufacturer will carry out the acceptance test on Aluminium and steel strands on 20% of the drums offered for inspection and will submit the records at the time of POWERGRID inspection.
- 12 The conductor manufacturer shall maintain records of the joints in inner layer of the conductor for all the drums and shall submit the records to POWERGRID for review at the time of Inspection.
- 13 Conductor sealing shall be as per approved sealing procedure. The conductor ends are required to be sealed with heat shrinkable sleeves and shall be properly secured with the drum by "U" clamps (nail), after covering the conductor with PVC adhesive tape to avoid loosening of conductor layers during transit and handling.
- 14 The drums shall be suitable for wheel mounting and letting off the conductor under minimum controlled tension of the order of 5 KN.
- 15 The manufacturer may supply the conductor in returnable/non-returnable (as per TS) painted steel drums. After preparation of steel surface according to IS 9954, synthetic enamel paint shall be applied after one coat of primer. For Wooden Drums, the inner cheek of the flanges & drum barrels surface shall be painted with Bitumen based paint.



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- 16 Before reeling, card board or double corrugated or thick bituminised water proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material over which HDPE sheet to be provided.
- 17 After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with self adhesive plastic sheet to preserve the conductor from ingress of water, dirt, grit and damages during storage, transport and handling.
- 18 Solid Polypropylene sheet of minimum 5 mm thickness shall be used for outer covering of conductor.
- 19 Outside the covering, there shall be minimum two binders consisting of hoop iron/galvanised steel wire.
- 20 The wood used in the drum shall preferably be neutral(non corrosive)with pH (aqueous extract) 5.5 to 7.5 and the wood preservative Copper used compound shall be avoided.
- 21 The Lay ratio of any Aluminium layer shall not be greater than the lay ratio of Aluminium layer immediately beneath it.
- 22 **The conductor manufacturer shall carry out process audits on quarterly basis at galvanized steel wire manufacturer works as per approved MQP of steel wire.**
The audit report shall be made available for POWERGRID review during product inspection/process audits.
- 23 Standard length & random length of conductor shall be governed as specified in POWERGRID technical specification.
- 24 Rejection & retests shall be as per IS 398 part 5.
In case of rejection of the offered lot of conductor/earthwire after testing as per MQP/Technical Specification/IS, the rejected material and the samples already tested shall be scrapped and strictly disposed off as follows:
 - a) The rejected lot/tested samples shall be clearly identified and stored separately to avoid any mix up with any in-process/finished lot till the same is disposed off.
 - b) The supplier shall arrange for cutting of the rejected conductor/earthwire lot in bits & pieces which shall be sold as scrap.
 - c) In case supplier intends to dispose off rejected material through any other mode, the same shall be done with approval of Corporate QA&I Department.
 - d) Necessary supporting documents in regard to (b) and (c) above, shall be submitted for verification of POWERGRID and record shall be maintained at manufacturer's works.
- 25 The manufacturer shall inform site and concerned inspection office for 1 sample per 500 km sample selection at site for re-acceptance test at TPL or at manufacturer's lab. (Refer CI in TS)
- 26 The size & acceptance test criteria for different types of conductor shall be as per approved GTP.
- 27 Following points are to be strictly adhered to if the lot is sales return drum (returned drum after damage during transit):
 - i) Conductor manufacturer shall specifically intimate POWERGRID IE, at the time of inspection, that the lot is for replenishment.
 - ii) No repaired conductor or sales return drum shall be offered to POWERGRID after re-layering
 - iii) Sales return drums shall be kept in manufacturer's works with different colour coding and shall not be disposed off until corresponding replenished new drums are cleared by POWERGRID.
 - iv) Conductor of these sales return drum shall be scrapped/cut into non standard length in presence of POWERGRID. In case of any difficulty or deviation, approval shall be taken from POWERGRID/CC/QA&I before disposal.
- 28 **This MQP is applicable for AAC (All Aluminum Conductors) also. However, for AAC, all tests pertaining to steel shall not be applicable.**



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Sr. No.	Components/ Operations & Description of Test	Type of Check	Quantum of Check/ Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
A. Section: RAW MATERIAL INSPECTION													
1.1 Aluminium Ingot													
1.1.1	Chemical Composition	Spectro Analysis	1 sample per heat of 9 MT or furnace capacity and part thereof One sample/lot of 100 MT or part thereof per supplier shall be tested	Suppliers TC IEC 60889 and POWERGRID Spec.	AL 99.5 % (min) Cu 0.04 % (max) Other elements as per GTP	Suppliers TC/ Manufacturer format of record (MFOR)	B	K	P	W	E	N	
1.2 Aluminium Wire Rod													
1.2.1	Chemical Composition	Spectro Analysis	1 sample per heat of 9 MT or furnace capacity and part thereof One sample/lot of 100 MT or part thereof per supplier shall be tested	Suppliers TC IEC 60889 and POWERGRID Spec.	AL 99.5% (min) Cu 0.04 % (max) Other elements as per GTP	Suppliers TC/ Manufacturer format of record (MFOR)/TPL	B	K	P	S/V	Z	N	
1.2.2	Diameter	Dimensional	1 sample from each coil.	IS 5484 and POWERGRID Spec.	Min. 9.00 mm, Nom. 9.50mm Max. 10.00 mm	Supplier TC & MFOR	A/B	J/K	S/P	Z	-	N	
1.2.3	Tensile Strength	Mechanical	1 sample from each coil.	Plant Standards	Min. 10.50 to 12 Kg/mm ² for Al strands dia less than 4 mm and 11.5 kg/mm2 min for strands dia ≥4 mm	Supplier TC & MFOR	A/B	J/K	S/P	Z	-	N	
1.2.4	Elongation	Mechanical	1 sample from each coil.	Plant Standards	Min. 8 % at 250 mm gauge length	Supplier TC & MFOR	A/B	J/K	S/P	Z	-	N	
1.2.5	Resistivity and Conductivity	Electrical	1 sample from each coil.	IS 5484, POWERGRID Spec.	Maximum resistivity 0.028264 ohm mm ² /metre at 20°C. Min. Conductivity 61.0 % of IACS.	Supplier TC & MFOR	A/B	J/K	S/P	Z	-	N	



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Sr. No.	Components/ Operations & Description of Test	Type of Check	Quantum of Check/ Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
1.2.6	Cleanliness and surface smoothness	Visual	100% on each coil	POWERGRID Spec.	The wire rod shall be sound, smooth and free from pipes, laps, cracks, kinks, twists, seams & other injurious defects within the limits of good commercial	Supplier TC & MFOR	A/B	J/K	S/P	Z	-	N	
2.1	High Tensile Galvanized Steel Wire												
2.1.1	Chemical Analysis	Chemical	One sample/lot of 100 MT or part thereof per supplier to be tested on receipt by conductor manufacturer	POWERGRID Spec./GTP	C 0.50 to 0.85 % Mn 0.50 to 1.10 % Si 0.10 to 0.35 % P 0.035 % (max) S 0.045 % (max)	Supplier TC TPL report / MFOR	A/D	J/L	S/V	Z		N	
2.1.2	Diameter	Dimensional	20 % Coils per lot	POWERGRID Spec./GTP	As per Approved Technical specification	Suppliers TC	B	K	P	Z	-	N	
2.1.3	Tensile Strength/ Breaking Load	Mechanical	10% Coils per lot	IEC 60888 & POWERGRID Spec./GTP	As per Approved Technical specification	MFOR Suppliers TC MFOR	A B A	J K J	S P S	Z Z Z	-	N N N	
2.1.4	Elongation	Mechanical	20 % Coils per lot 10% Coils per lot	IEC 60888 & POWERGRID Spec./GTP	Min.4.0 % at 250 mm gauge length.	Suppliers TC MFOR	B A	K J	P S	Z Z	-	N N	
2.1.5	Torsion Test	Mechanical	20 % Coils per lot 10% Coils per lot	IEC 60888 & POWERGRID Spec./GTP	Min.18 twist on a gauge length of 100xdiameter of wire	Suppliers TC MFOR	B A	K J	P S	Z Z	-	N N	
2.1.6	Wrapping Test	Mechanical	20 % Coils per lot 10% Coils per lot	IEC 60888 & POWERGRID Spec./GTP	Wrap-8, unwrap-6 & wrap-6 On a mandrel having diameter equal to 4 x diameter of wire. The wire shall not break.	Suppliers TC MFOR	B A	K J	P S	Z Z	-	N N	

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Sr. No.	Components/ Operations & Description of Test	Type of Check	Quantum of Check/ Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
2.1.7	Adhesion Test	Mechanical	20 % Coils per lot	IEC 60888 & POWERGRID Spec./GTP	The Zinc coating shall remain adherent to the steel wire when wound 10 turns on a mandrel having diameter equal to 4 x The diameter of wire	Suppliers TC MFOR	B	K	P	Z	-	N	
			10% Coils per lot				A	J	S	Z		N	
2.1.8	Preece Test (Dip Test)	Chemical	20 % Coils per lot	POWERGRID Spec./GTP	As per Approved Technical specification	Suppliers TC	B	K	P	Z	-	N	
2.1.9	Mass of Zinc coating	Chemical	10% Coils per lot	IEC 60888 & POWERGRID Spec./GTP	As per Approved Technical specification	MFOR	A	J	S	Z		N	
			20 % Coils per lot				B	K	P	Z	-	N	
2.1.10	Surface finish of GS Wire coils	Visual	100 % Coils per lot	IEC 60888 & POWERGRID Spec./GTP	The Wires shall be smooth, uniform and free from imperfections such as spills, splits, scale inclusion, die marks, scratches, abrasion, blow holes etc.	Suppliers TC	B	K	P	Z	-	N	
			100 % Coils per lot				A	J	S	Z		N	
2.1.11	Check for Joints	Visual	100 % Coils per lot	IEC 60888 & POWERGRID Spec./GTP	There shall be NO JOINT	Suppliers TC	B	K	P	Z	-	N	
			100 % Coils per lot				A	J	S	Z		N	
2.1.12	Purity of Zinc	Chemical	1 sample for every lot of 100 MT or part thereof	IS 209 and POWERGRID Spec.	Min. Purity of Zinc 99.95 %	Suppliers TC	D	L	V	Z	-	N	

