



GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

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**TECHNICAL SPECIFICATION
FOR UPRATING OF EXISTING
66 KV TRANSMISSION LINE
BY
HIGH AMPACITY (HTLS) CONDUCTOR**

GETCO/E/TS SEL054-66KV HTLS/R1 Aug. 2023

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SECTION- I

TECHNICAL SPECIFICATION

1. General Information and Scope

1.1 Scope :

The scope of this Technical Specification shall be considered as follows

- 1.1.1 The turn key work involves Up-rating of current carrying capacity of existing 66 kV lines, as per Annexure, by HTLS conductor with continuous current carrying capacity of minimum 550 Amps. without deteriorating mechanical & metallurgical properties of conductor with corresponding operating temperature not more than 210°C.

The work involves procurement, supply, Hot Line stringing & commissioning of HTLS conductor having equal to or lesser diameter as well as unit weight as that of ACSR Dog conductor with all necessary suitable hardware & accessories suitable to withstand designed temperature of HTLS conductor and silicon rubber insulators having creepage distance 31mm/kV on existing 66 kV Transmission line structure, after dismantling of existing ACSR Dog conductor, hardware & accessories and insulators.

- 1.1.2 Submission of complete Technical details of the proposed HTLS conductor with relevant calculation to adjudge the sufficiency of existing Towers and / or H frame structure for carrying out the up-rating works. This shall be carried out in strict compliances/ adherence to all safety and standards requirements as per Indian Electricity Rules/IS. ROW clearances if required shall be in the scope of Bidder.

The scope also includes detailed survey of existing line & preparation of profile with existing tower / H frame structure and proposed conductor indicating all types of crossings to ascertain sufficient clearances available as per IS/IE rules. Design and submission of detailed drawings of hardware and accessories. Preparation and submission of stringing chart etc. are included in the scope of the Bidder.

1.2 Design Parameter

Design and other parameters on which the up-rating is required are,

- a) Climatic & Technical details: The climatic condition and system parameters are given in Clause No 10, Section I of this specification.
- b) **Conductor Type:**
 - i) Type of conductor offered shall be suggested by bidder having physical characteristics of ACSR Dog Conductor, including equal to or lesser diameter as well as unit weight as that of ACSR Dog Conductor in order to ensure

- replacement without affecting existing loading and other conditions of the existing transmission line. UTS of offered conductor shall be equal to or higher than UTS of ACSR Dog conductor, specified in technical particulars.
- ii) Mid span clearances of top conductor with respect to earth wire shall be maintained as per IS.
 - iii) Conductor shall be retrofitted on existing structure to increase current capacity.
 - iv) Overall conductor design should be such that it can carry minimum 550 Amperes on continuous basis without deteriorating mechanical & metallurgical properties of conductor with allowable maximum conductor temperature not more than 210°C. Bidder can offer higher amperes.
 - v) During detailed engineering stage, in case any changes are required in offered design of HTLS conductor to comply the stipulated requirement of technical specification, the same shall be carried out without any extra cost to purchaser.
- c) **Current Carrying capacity/ Ampacity of proposed Conductor**
 Conductor shall be suitable to carry alternating current minimum 550 Amperes at 50 Hz. on continuous basis without deteriorating mechanical & metallurgical properties of conductor under the specified following ambient conditions having conductor sag not more than specified below, while satisfying other specified technical requirements.
- i) Ambient temperature = 40 °C
 - ii) Solar Absorption coefficient = 0.8
 - iii) Solar Radiation = 1045 Watt/sq. mtr.
 - iv) Emissivity Constant = 0.45
 - v) Wind Velocity = 0.56 meter/sec (considering angle between wind and conductor axis as 90)
 - vi) Effective angle of incidence of Sun's rays = 90 degrees.
 - vii) Maximum steady state temperature of conductor $\leq 210^{\circ}\text{C}$
 - viii) Maximum altitude above sea level - < 1000 meters
 - ix) Wind on wire = 45 kg/sq. mtr.
 - x) Wind on Tower = 195 kg/sq. mtr.
 - xi) Towers are designed as per IS 802, 1977

For Towers maximum conductor sag for 260 mtr. span at no wind and steady state conductor temperature, corresponding to 50 Hz AC of minimum 550 Amps under ambient conditions specified above, shall be 5.33 mtr.

For H frame structures maximum conductor sag for 190 mtr. span at no wind and steady state conductor temperature, corresponding to 50 Hz AC of minimum 550 Amps under ambient conditions specified above, shall be 3.465 mtr.

The detailed Ampacity calculations shall be submitted with technical bid based on IEEE Standard 738 for the proposed HTLS conductor. Ratio of AC resistance & DC resistance for HTLS conductor shall be calculated on the basis of *CEA Guideline for Rationalized use of High Performance Conductor* or the formulae indicated as below:

$$R_{ac} = R_{dc} \times (1 + 0.00519 \times (mr)^n \times k_1 + k_2) \text{ where,}$$

R_{dc} = DC resistance of conductor at given temperature, ohms/km.,

R_{ac} = AC resistance of conductor at given temperature, ohms/km.

$$mr = 0.3544938 / (R_{dc})^{1/2}$$

if $mr < 2.8$, then $n = 4 - 0.0616 + 0.0896 \times mr - 0.0513 \times (mr)^2$

if $2.8 < mr < 5.0$, then $n = 4 + 0.5363 - 0.2949 \times mr + 0.0097 \times (mr)^2$

$k_1 = \{\cos[90(d/D)^p]\}^{2.35}$ where,

$$p = 0.7 + 0.11 \times mr - 0.04 \times mr^2 + 0.0094 \times mr^3$$

$k_2 = 0.15$ for single aluminum layer HTLS conductor

= 0.03 for three aluminum layer HTLS conductor

= 0.003 for two or four aluminium layer HTLS conductor

= 0 for composite core type HTLS conductor

Where,

D = conductor outer diameter in meters

d = conductor inner diameter in meters

The Bidder shall also indicate the maximum permissible conductor temperature & period for continuous operation for proposed conductor without any deterioration of its electrical, mechanical & metallurgical properties, in the technical bid.

The Bidder shall indicate the technical particulars and details of the construction of the conductor in the relevant schedule of GTP and submit proposed conductor detailed sectional view indicating layer wise diameter. The Bidder shall also guarantee the DC resistance of conductor at 20°C and AC resistance at the calculated temperature corresponding to 50Hz AC with the flow of minimum 550 Amperes at specified ambient conditions (maximum continuous operating temperature).

The Bidder shall submit the supporting calculations for the AC resistance indicating details.

The Bidder shall submit the type test reports from Govt. approved/ NABL Lab (National accreditation body of the country where laboratory is located) in support of DC resistance for proposed conductor design.

- d) The bidder has to declare UTS of the conductor in GTP for Ambient Temperature (AT) & for designed maximum temperature. UTS value at designed maximum temperature shall not be less than 70% of conductor UTS at AT.

The bidder has to specify UTS of core & maximum permissible load allowed on core for various sag-tension conditions esp. at knee point. The bidder has to give detailed calculation for core UTS. The bidder also has to specify maximum continuous operating temperature of core. Also, to satisfy that core temperature is well within limit when conductor is operated at designed temperature.

- e) Sag-Tension calculations: Shall be submitted comparing existing and proposed conductor type at various temperature levels with ampacity. The Bidder shall also furnish sag & tension under no wind, for various temperatures starting from 0 °C to maximum continuous operating temperature in steps of 5 °C. The Bidder shall also furnish sag & tension under 67% full wind 0 °C & 100% full wind at 32 °C for proposed conductor.
- i) For Tower: The limiting values of sag-tension are given below for ruling span of 260 meters.

Condition	Limiting Value
32 °C No Wind – Tension	$\leq 25\%$ of proposed conductor UTS
0 °C No Wind – Sag	≥ 2.917 meters
0 °C 67% Full Wind - Tension	≤ 1329 kgs. (wind on wire 30 kg/sq. mtr.)
32 °C 100% Full Wind - Tension	≤ 1223 kgs. (wind on wire 45 kg/sq. mtr.)
Designed temperature (corresponding to 550 Amp. @ ambient conditions given (c) above) No Wind -Sag	≤ 5.33 meters
Tension at knee point temperature & no wind	Not exceeding limits specified in (d) above

- ii) For H frame structure: The limiting values of sag-tension are given below for ruling span of 190 meters.

Condition	Limiting Value
32 °C No Wind – Tension	$\leq 25\%$ of proposed conductor UTS
0 °C No Wind – Sag (applicable for span where existing 66 kV line is crossed by another line)	To meet electrical clearance required by IS.

0 °C 67% Full Wind - Tension	≤1215 kgs. (wind on wire 30 kg/sq. mtr.)
32 °C 100% Full Wind - Tension	≤ 1045 kgs. (wind on wire 45 kg/sq. mtr.)
Designed temperature (corresponding to 550 Amp. @ ambient conditions given (c) above) No Wind -Sag	≤ 3.465 meters
Tension at knee point temperature & no wind	Not exceeding limits specified in (d) above

It shall be noted that for proposed conductor, maximum sag in any section shall be less than sag of ACSR Dog conductor @ 67°C in that section, provided tension limits are meet. It shall be ensured by preparation of profile with existing conductor existing condition & overlapped by proposed conductor.

Sag-Tension calculation for HTLS conductor can be carried out using PLSCAD. Values considered in cable data (.wir) file shall be justified & shared with purchaser. It shall be existing file for offered conductor on PLS website or derived from existing file for equivalent conductor or file derived based on type test conducted.

Bidder shall also furnish details of creep characteristics in respect of HTLS conductor based on laboratory investigations / experimentations (creep test as per IEEE1138) conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6month, 1year & 10year creep at everyday tension & at maximum continuous operating temperature.

- f) Design of Hardware should be compatible with proposed conductor and existing / new insulators and structure. As a part of technical qualifying requirement, Hardware & Accessories manufacturer shall have experience in design, manufacturing, testing & supply of various HTLS category conductor hardware-accessories & shall have supplied hardware-accessories suitable for same technology conductor as offered for the bid & be in service for minimum 2 years as on opening of the technical bid.
- g) The scope includes inspection of tower / H frame structure to ascertain missing members and bolt-nuts, procurement, fabrication and erection of such assorted missing members.
- h) The scope includes inspection of tower / H frame structure to ascertain any damage to stub / foundation chimney which requires stub strengthening. Required stub strengthening shall be carried out in accordance with GETCO procedure.

1.3 Manufacturing Quality Plan

Manufacturing Quality Plan (MQP) for proposed conductor and Hardware & Accessories shall be submitted with the Technical Bid.

1.4 Workmanship

- i) All the conductor strands shall be smooth, uniform and free from all imperfections, such as spills and splits, cracks, die marks, scratches, abrasions, rust etc.
- ii) 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.

1.5 Joints in wires

a) Aluminium or Aluminium Alloy Wires

During stranding no Aluminium or Aluminium Alloy welds are permitted for the purpose of achieving the required conductor length.

No joints shall be permitted in the individual wires in the outermost layer of the finished conductor. However, joints are permitted in the inner layer(s) of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or due to short length of wire. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from any other joint in conductor. A record of such joints shall be maintained by manufacturer & furnished to GETCO at the time of inspection offered. Joints shall be made by cold pressure butt weld and shall have breaking strength not less than that of un-joint strand.

b) Core 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 joints or splices in any length of the completed solid or stranded core. However, for composite core, smooth splicing of galvanic protection barrier only is allowed at production stage.

1.6 Tolerances

Manufacturing tolerances on the dimensions to the extent of one ($\pm 1\%$) percent shall be permitted for individual strands and the complete conductor.

In case of composite core, the tolerance shall be as per applicable standard.

1.7 Materials

The materials used for construction of the conductor shall be such that the conductor meets the specified technical and performance requirements.

a) Outer Layer

The material of outer layer of HTLS conductor shall be of high temperature resistant Aluminium or Aluminium alloy added with zirconium or any other suitable elements etc. to electrolytic Aluminium or annealed Aluminium having purity not less than 99.5% and a copper content not exceeding 0.04%. The strands shall be manufactured to meet electrical mechanical and metallurgical properties under continuous high temperature operation. Bidder shall guarantee the chemical composition in the schedule GTP and also furnish description of the manufacturing process in the bid.

b) Core

The core wire strands shall be of galvanized steel wires/Aluminium clad steel wires/zinc-5% Aluminium-misch metal alloy coated invar wires/galvanized invar wire/Aluminium clad invar wires/composite materials etc. and shall have properties conforming to the technical performance requirements of the finished conductor. Bidder shall furnish properties and composition of the core wire strands in the schedule GTP.

The zinc used for galvanizing in case of steel/invar core shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS 209. The minimum mass of zinc coating shall be as per requirements of class –I coating as per IEC888. Zinc-5% Aluminium-misch metal alloy coating if used, shall confirm to ASTM B803/B958.

The Aluminium cladding of invar/steel wires shall be with Aluminium having purity not less than 99.5% and shall be thoroughly bonded to the core wire strands. The minimum thickness of Aluminium cladding shall be 0.07 mm to achieve a minimum conductivity of 14% of IACS.

Where composite material for core is offered, the materials shall be of such proven quality that its properties are not adversely influenced by the normal operating conditions of 66 kV transmission line in tropical environment conditions as experienced by the existing line. The Bidder shall provide adequate details including specifications/test reports/ operating experience details/performance certificates etc. in support of the suitability of the offered materials. The composite material core shall be in strict compliance with ASTM B987 (latest amendment).

Design & material of offered core shall be confirming to internationally accepted standard or any National standard only. Bidder have to

submit such support standard (with latest amendment) at the time of bid.

2 Conductor Length

- i) The Bidder after his survey of the existing line shall determine the most appropriate individual conductor lengths to be manufactured & supplied keeping in view tower schedules, section lengths, special crossings etc. The conductor shall be supplied on returnable steel drums as per the attached specification. However, the steel drum for spare conductor shall be on non-returnable basis. Barrel diameter of drum shall be in line with bending radius recommendation applicable if any & long duration storage recommendation if any.
- ii) The Bidder shall also indicate in the GTP, the maximum single length of HTLS Conductor, which he can manufacture, but the same shall be in line with requirement of (i) above.
- iii) No Repair Sleeve is allowed.
- iv) However, Mid Span Joint may be allowed to use only in longer section lengths of more than 2 kms, but will not be allowed on account of conductor damage. However, the Mid Span Joint shall be on bidder's account & no extra cost will be paid by GETCO. The bidder shall have to prove technical suitability of Mid Span Joint with proposed HTLS conductor with all support documents & related tests, without compromising proposed HTLS conductor performance. The same shall be got approved in advance.
- v) No Mid Span Joint is allowed for use with proposed gap type conductor. The bidder has to arrange drum lengths accordingly.

3 Evaluation of Ohmic losses & Differential Price Loading:

Based on the conductor parameters guaranteed by the bidders, average Ohmic losses for different type of conductors offered by the bidders shall be calculated as per the following formula:

(Note: For double circuit line the above calculated value shall be doubled.)

$$\text{Average Ohmic Loss (kw)} = \text{Loss Load Factor} \times 3 \times \text{Line Length} \times \text{No. of sub-conductors} \times (\text{specified continuous operating current})^2 \times \text{AC Resistance corresponding to specified continuous operating current.}$$

The value of Average Ohmic Loss (kw) = $182.25 \times \text{Line Length (in ckm.)} \times R_{ac}$,

where (1) *Line Length* is total length of lines proposed for up-rating in ckm. i.e. 3 phase (2) *R_{ac}* is the AC resistance per km. guaranteed by the bidder at temperature corresponding to the continuous operating current of 450 Amp. for proposed conductor.

Differential price evaluation for the conductor offered by the bidders shall be carried out considering the average Ohmic losses calculated as above and considering Rs. 1,60,000 per kw.

The best parameter of loss (lowest Ohmic loss for conductor) corresponding to lowest AC resistance quoted among bidders by any technically responsive & qualified bidder shall be taken as basis and that quoted by the particular bidder shall be used to arrive at differential price to be applied for each bid.

4 Tests (REFER ANNEXURE A)

4.1 Type Tests:

The following Type tests reports shall be submitted along with the Technical bid, not older than 10 years, as on last date of submission of bid, for HTLS conductor similar to the offered, from Govt. approved/ NABL Lab (National accreditation body of the country where laboratory is located) of the proposed works of the bidder.

A) On complete Conductor

a)	DC resistance test	:As per Ann.- A
b)	Ultimate Tensile Strength test @ room temp. & design temperature	:As per Ann.- A
c)	Lay ratio & direction test	:As per Ann.- A
d)	Stress – Strain test on stranded conductor & core at room temp.	:As per Ann.- A
e)	Stress – Strain test on stranded conductor and core at elevated temperature	:As per Ann.- A
f)	High temperature endurance & creep test on stranded conductor	:As per Ann.- A
g)	Sheaves test	:As per Ann.- A
h)	Axial Impact test	:As per Ann.- A
i)	Radial Crush Test (Crush Strength test)	:As per Ann.- A
j)	Torsional Ductility Test	:As per Ann.- A
k)	Dimensional check on core strands/composite core and Aluminium Alloy strands	:As per Ann.- A
l)	Temperature cycle test	:As per Ann.- A
m)	Aeolian vibration test	:As per Ann.- A
n)	Design validation test on the class of core being offered for Composite Core	: ASTM B987
On Conductor Strand/core		
o)	Heat resistance test on Aluminium Alloy strands or core	:As per Ann.- A
p)	Bending test on core	:As per Ann.- A
q)	Compression test on core	:As per Ann.- A
r)	Coefficient of linear expansion on core/ core strands	:As per Ann.- A

s)	Strand Brittle fracture test (for polymer composite core only)	:As per Ann.- A
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Those bidders who have submitted all TTR of equivalent or higher rating / size conductor of same offered construction shall be considered for evaluation subject to confirmation to carry out TT at NABL, free of cost to GETCO, without affecting delivery schedule, before commencement of supply, on offered size/rating conductor/core. However, it is mandatory for bidder to submit tests at sr. no. (a, b, k, n, o, r) as minimum type tests requirement, performed on offered conductor OR equivalent or higher rating / size conductor of same offered construction, performed at respective National Accredited laboratory, shall only be considered for evaluation. No material shall be offered and accepted without any of the type test/s pending.

Those bidders who have submitted some of the type test reports of offered conductor shall be considered for evaluation subject to confirmation to submit/carry out balance TT at NABL, free of cost to GETCO, without affecting delivery schedule, before commencement of supply.

However, pending tests shall have to be carried out on samples selected by GETCO representative from the offered HTLS conductor drums in event of the order. These tests shall be carried out on samples prior to commencement of commercial production against the order. The supplier shall intimate the purchaser about schedule of carrying out of the type tests along with detailed testing program for deputation of purchaser representative for selection of sample. The supplier shall offer at least three (3) drums for selection of samples required for conducting all the type tests. The Supplier shall indicate his schedule for carrying out these tests in the activity schedule. GETCO reserves the right to specify the name of the laboratory also, if so felt. For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Bidder in the "Guaranteed Technical Particulars", of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

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

B) On Hardware & Accessories – suitable for offered HTLS conductor

- a) Visual examination & verification of dimension
- b) Slip strength of clamp

- c) Ultimate Tensile Strength
- d) Chemical composition test
- e) Galvanizing test
- f) Temperature Rise test with proposed conductor operating temperature & 25% conductor UTS – As per Ann. – A.
- g) Heating cycle & Electrical resistance test

C) Silicon Rubber Insulator – As per specifications

Those bidders who have submitted some of the type test reports for item (B) & (C) above suitable for offered HTLS conductor shall be considered for evaluation subject to confirmation to submit/carry out balance TT at NABL, free of cost to GETCO, without affecting delivery schedule, before commencement of supply.

4.2 Acceptance tests: These tests shall be carried out at the manufacturer's works in presence of GETCO's representative before the dispatch of the materials to the site.

A) On Conductor: The following Acceptance Tests shall be carried out on samples selected from offered lot at the rate of 10% of drum. However, GETCO reserves the right to reduce sampling rate OR waiver of inspection, based on confidence build-up with product.

a)	Visual and dimensional check on drum	As per Ann.-A
b)	Visual check for joints scratches etc and length measurement of conductor by rewinding	As per Ann.-A
c)	Dimensional check on core strands/composite core and Aluminium Alloy strands	As per Ann.-A
d)	Check for lay-ratios & direction of various layers	As per Ann.-A
e)	Galvanizing test on core strands (if applicable)	As per Ann.-A
f)	Aluminium thickness on Aluminium clad wires (if applicable)	IEC:61232
g)	Bending, Torsion and %Elongation tests on core strands/composite core (as applicable)	As per Ann.-A
h)	Breaking load test on core strands and Aluminium/Aluminium alloy strands	As per Ann.-A
i)	Wrap test on core strands and Aluminium alloy strands	As per Ann.-A
j)	DC Resistance test on strands and total conductor	As per Ann.-A
k)	Crush strength test	As per Ann.-A
l)	Heat resistance test on Aluminium alloy strands	As per Ann.-A
m)	Ageing test on filler (if applicable)	As per Ann.-A
n)	Coefficient of linear expansion on core/core strands	As per Ann.-A
o)	Resistivity test on Aluminium clad core strands	As per IEC-468

p)	Glass transition temperature test (for polymer composite core)	As per Ann.-A
q)	Galvanic Protection Barrier Layer Thickness test (on polymer composite core)	As per ASTM B987
r)	Flexural strength test (for polymer composite core)	As per Ann.-A
s)	Strand BFRT test (for polymer composite core)	As per Ann.-A
t)	Coating Test on Zinc – 5% Al -Mischmetal alloy Coating (if applicable)	As per ASTM B803/B958
u)	Adherence of Coating Test on Zinc – 5% Al Mischmetal alloy Coating (if applicable)	As per ASTM B803/B958

The following acceptance tests shall be carried out on samples selected from offered lot at the rate of 100% of drums.

- Visual examination
- Measurement of diameter & weight
- DC Resistance Test

Note 1: No positive tolerance in the offered as well as Type Tested value of resistance is permissible. However negative tolerance is acceptable. If positive tolerance is observed, the conductor will be out rightly rejected.

Note 2: In case of polymer composite core, acceptance tests, viz., {b,c,g,h,n,p,q,r,s} shall be performed on core before stranding as stage inspection & shall be in line with ASTM B987, which shall be specified in MQP.

B) On Hardware & Accessories – with offered conductor, as per applicable IS/IEC for respective article,

- Visual examination & verification of dimension
- Slip strength of clamp
- Ultimate Tensile Strength
- Chemical composition test
- Galvanizing test
- Temperature Rise test with proposed conductor operating temperature & 25% conductor UTS.

C) Silicon Rubber Insulator – As per specifications

Routine Test: Routine Tests shall mean those tests which are to be carried out on each strand/spool/length of the conductor to check requirements which are likely to vary during production. These tests shall be carried out by the manufacturer on each drum and shall have to furnish report with inspection call and to the GETCO's representative during his visit for acceptance tests.

A) On Conductor

- 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 tests as mentioned above to be carried out on each coil as per cl. 4.2 above
- e) For CFC core – all routine tests as per ASTM B987, Table 1.

Tests During Manufacture

- a) Chemical analysis of zinc used for galvanizing - As per Ann.-A
- b) Chemical analysis of Aluminium alloy used for making Aluminium Alloy strands - As per Ann.-A
- c) Chemical analysis of core strands (not on polymer composite core) As per Ann.-A

GETCO have right to inspect raw material or ask to submit tests for verification of raw material before manufacturing conductor, as per the approved manufacturing Quality Plan.

B) On Hardware & Accessories –

- a) Visual examination
- b) Routine mechanical strength

C) Silicon Rubber Insulator – As per specifications

Additional Tests – on Conductor & Hardware/Accessories

- a) The purchase reserves the right of having at his own expenses any other tests of reasonable nature carried out at Suppliers premises, at site or at any other place, in addition to the aforesaid type, acceptance and routine tests, to satisfy him that the materials comply with the Specifications.
- b) The purchaser also reserves the right to conduct all the tests mentioned in this specification at his own expense on the sample drawn from the site at supplier's premises or at any other laboratory. In case of evidence of noncompliance, it shall be binding on the part of supplier to prove the compliance of the items to technical specifications by repeat tests or correction of the deficiencies or replacement of defective items without any extra cost to purchaser.

Hardware fittings:

The bending amplitude at the conductor's suspension should be minimum to prevent fatigue.

The suspension clamps are so selected that vibration related problems should be perceived to be minimum. The preformed armour rod if any, shall be considered part of Suspension assembly.

5 General

- 5.1 GETCO may call the adjudged bidder(s) to give presentation on their solutions/ methodologies proposed for execution of the project and submit additional information as may be required to adjudge completeness of the offer, during tender scrutiny.
- 5.2 The interested bidder may visit the work site to acquaint himself fully with the climatic, environmental and physical conditions prevailing.
- 5.3 Transportation of all materials to erection site and transit insurance of material to be supplied / transported, shall be part of scope of supply.
- 5.4 Hot line stringing work for Double Circuit line.
- 5.5 Stringing activity shall be supervised by trained supervisor of conductor supplier / manufacturer to ensure no damage to conductor & adoption of correct procedure to ensure conductor's HTLS operation during lifelong.
- 5.6 The successful bidder will have to impart training to GETCO technical persons before starting of first stringing activity. It shall include visuals, videos, practical demonstrations, safety precautions required, correct & incorrect handlings etc.
- 5.7 The stringing shall be permitted in phased manner as feasible & at discretion of GETCO.
- 5.8 For replacement of conductor being a Hot Line job (One circuit being charged when one circuit under outage) necessary shut down shall be arranged by GETCO. In critical grid condition if shut down not made available then no any claim will be entertained towards idling charge etc. However, the proportionate extension in construction period can be given. Further even if shut down is given the bidder has to plan work in such a manner to quickly restore the entire line in case of grid emergency as directed by GETCO. All temporary arrangement required shall be made by the successful bidder at no extra cost to GETCO.
- 5.9 Data once offered in the bid for quoted current capacity, temperature and resistance, shall not be allowed to change by bidder.
- 5.10 Other items not specifically mentioned in this Specification and are required for the successful dismantling, erection, testing and commissioning of the transmission line, shall be considered in the scope.
- 5.11 Any damage to existing tower / H frame structure during conductor replacement work will be on bidder's account. The restoration work shall be carried out without extra cost to GETCO on war footing basis. However, in such situation, GETCO reserves right to restore line at their own through any other agency to avoid delay, at the risk & cost of successful bidder & free of cost to GETCO.
- 5.12 In an event of any material used for transmission line found to be broken or damaged or received short during transit or failed during the erection/ testing at site before commissioning of line, the Bidder shall replace the same free of cost.

6 Requirement of equipment, tools-tackles & materials:

All the materials, tools-tackles, equipments etc. required for successful completion of work, shall be arranged by the successful Bidder in

sufficient quantity before the work is taken up on hand and shall not be linked with the delivery/completion period with non-procurement or arrangement made by him for these items.

7 Inspection:

- 7.1 The inspection of materials shall be carried out as per the relevant standards at the manufacturer's works for all acceptance tests.
- 7.2 If the testing facilities are not available at the manufacturer's works the same shall be carried out at third party laboratory at no extra cost to the GETCO. GETCO reserves right to specify such laboratory.
- 7.3 The Bidder shall replace the materials if not found as per the specific requirements at no extra cost to the GETCO, including testing charges if any.
- 7.4 The Bidder shall intimate the date for inspection well in advance i.e. at least 15 days before for Indian manufacturer & 3 months for overseas manufacturer, to enable GETCO to depute his representative for inspection.
- 7.5 All Acceptance tests is to be carried out at manufacturer's works prior to dispatch whether the Indian or foreign manufacturer. In case of waiver of Acceptance testing at manufacturer's works by GETCO in case of overseas conductor/Hardware & accessories/SRI manufacturer, Acceptance tests shall be arranged in Indian NABL/Govt. Approved Lab. OR other lab. approved by purchaser. All necessary arrangements & cost shall be borne by the bidder.
- 7.6 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 the representative shall have full facilities for unrestricted inspection of the suppliers works raw materials and process of manufacture and conducting necessary tests as may be deemed fit, for certifying the quality of product.
- 7.7 The acceptance of any quantity of material shall in no way relieve 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.
- 7.8 The bidder shall have to submit all routine test certificates along with inspection call for offered material. The bidder also has to submit records of joints for conductor strand in line with cl. 1.5 above.

8 Marking:

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

- (a) A/T letter number & date
- (b) Name and address of consignee
- (c) Manufacturer's name and address
- (d) Drum number
- (e) Type & Size of conductor
- (f) Length of conductor in meters

- (g) Arrow marking for unwinding
- (h) Position of the conductor ends
- (i) Distance between outer-most Layer of conductor and the inner surface of lagging.
- (j) Gross weight of drum after putting lagging.
- (m)Tear weight of the drum without lagging.
- (n) Net weight of the conductor in the drum.
- (o) Inspection Call No.

The above should be indicated in the packing list also.

Drum marking shall be a part of GTP, bidder has to provide relevant detail with tender bid. Successful Bidder has to get approval of drum schedule before offering inspection of material.

While offering the material for inspection, Inspector will check the drum marking as per approved MQP & sign with seal the corresponding drum, also record the details in MOM of inspection report.

9 Dispatch of Materials:

- 9.1 All the materials shall be dispatched only after inspection and after receipt of dispatch clearance from the Chief Engineer (Project), Corporate Office, GETCO-Vadodara.
- 9.2 Delivery of materials after satisfactory inspection and clearance shall have to be taken by the Bidder and to be stored in their store at site within the vicinity of transmission line till its utilization on the line.
- 9.3 Intimation/proof of receipt i.e. TRC and S.R Note of Conductor, Hardware and Accessories for conductor at Bidder's store will be issued by the concern Executive Engineer (Const) GETCO, from time to time. The defective materials should be replaced by the Bidder without charging any extra cost to the GETCO.
- 9.4 Successful Bidder shall obtain permission from concern Construction Division Office before making Arrangement for stacking of material at site (Yards/Stores) as and when required. The cost and handling of storage shall be to the Bidder's account.

10 Wastages:

- 10.1 The conductor, Silicone rubber insulators, hardware & accessories for conductor are to be procured by the successful Bidder and shall make his own arrangement for storage to avoid breakage, losses and wastage of material etc.
- 10.2 The maximum ceiling for wastages permitted is as under:

Sr. No.	Item	% wastages permitted (Maximum)
1)	Conductor	½ % (for sag & jumper)

10.3 No wastage is allowed for any material except the percentage limit mentioned for Conductor here in above in Clause No. 10.2

11 GENERAL INFORMATION & SYSTEM DATA

11.1 CLIMATIC CONDITIONS

- i) Location : In the State of Gujarat.
- ii) Maximum Ambient Air Temperature. : 50 °C
- iii) Minimum Ambient Air Température. : 0 °C
- iv) Average daily ambient Air Temperature : 32 °C
- v) Maximum relative humidity. : 95 %
- vi) Average rainfall per annum. : 1150 mm
- vii) Maximum altitude above mean sea level : 1000 mtr.
- viii) Ceraunic level i.e. Average number of Thunder storm – Days/annum : 15
- ix) Maximum wind pressure. (Kg/Sq. meters) : 200
- ix) Seismic level i.e. Earthquake Acceleration
 - a) Horizontal Seismic Co-efficient (Acceleration) – G (Zone – 5) :0.08
 - b) Vertical Seismic Co-efficient (Acceleration) – G (Zone – 5) :0.84

11.2 SYSTEM PARTICULARS

a)	System Voltage (KV rms)	66
b)	Max. Voltage (KV rms)	72.5
c)	Lightning impulse withstand voltage (dry & wet) (KVP)	350
d)	Power Frequency withstand voltage (wet) (KV rms)	140
e)	Short circuit level	40 kA

f)	Frequency – Hz a) Normal b) Maximum III) Minimum	50 51 47	
g)	Number of Circuits	Single/Double	
h)	Normal Span	260 mtr. (Tower)	190 mtr. (H frame)
i)	Wind Span	260 mtr.	190 mtr.
j)	Weight Span a) Maximum b) Minimum	390 mtr 225 mtr	***
k)	Tension in kgs. (at 32 °C & No wind)	826 (25% of UTS)	726

11.3 TOWER DETAILS

a) 66 kV DOUBLE CIRCUIT TOWER

Type of Tower	Deviation Limit	Typical Use	
DP	0 deg	used as tangent tower	
DQ	0 deg-15deg	a)	Angle tower with tension insulator string.
	0 deg	b)	used as section tower.
DR	15 deg-30deg	Angle tower with tension insulator string.	
DS	30 deg-60deg	a)	Angle tower with tension insulator string.
		b)	Dead end with 0 deg to 15 deg deviation both on line and substation side (slack span)

b) 66 kV H FRAME STRUCTURE

Type of H Frame	Typical Use
A	used as Suspension structure
B	Low Angle with tension insulator string.
C	Medium / Large Angle with tension insulator string.
	Dead end with 0 deg to 15 deg deviation both on line and substation side

11.4 66 kV D/C TOWER SPOTTING DATA

Sr. No.	Description	TOWER TYPE							
		2° (DP)		15° (DQ)		30° (DR)		60° (DS)	
	Broken Wire	GW or Any one cond.		GW and Any one cond. Or 2 cond on same side		GW and Any one cond. Or 2 cond on same side		GW and Any two cond. Or 3 cond on same side	
1.	Deviation not to exceed	2°		15°		30°		60°	
2	Normal Span – meters	260							
3	Maximum weight span								
	Ground wire : Effect of both spans.	390		390		390		390	
	: Effect of one span	225		225		225		225	
	Conductor : Effect of both spans.	390		390		390		390	
	: Effect of one span	225		225		225		225	
	Minimum weight span								
	Ground wire : Effect of both spans.	172		172		172		172	
	: Effect of one span	104		104		104		104	
	Conductor : Effect of both spans.	172		172		172		172	
	: Effect of one span	104		104		104		104	
	Permissible sum of adjacent spans for various deviation angles. Based on the condition that required Ground clearance is available.	2°	520	15°	520	30°	520	60°	520
		1°	563	14°	563	29°	562	59°	558
		0°	608	13°	608	28°	605	58°	596
				12°	650	27°	648	57°	635
			11°	695	26°	690	56°	674	
			10°	736	25°	734	55°	713	

SAG TENSION VALUE. (Tower Structure) :

Sr No	Description	Conductor		Earthwire	
		Sag (meter)	Tension (Kg)	Sag (meter)	Tension (Kg)
1	32 °C & full wind	-	1223	-	1132
2	0 °C & 2/3 full wind	-	1329	-	1210
3	67 °C & No wind	5.33	625	4.67 (53 °C)	773 (53 °C)
4	0 °C & No wind	2.917	1141	3.238	1114

SAG TENSION VALUE. (H Frame Structure) :

Sr No	Description	Conductor	
		Sag (meter)	Tension (Kg)
1	32 °C & full wind	-	1045
2	0 °C & 2/3 full wind	-	1215
3	67 °C & No wind	3.465	513

11.5 DETAILS OF EXISTING LINE MATERIALS

A. Conductor and Earth wire for 66 kV Dog Conductor line

Sr. No.	Description	Unit	Earthwire	Conductor
	Name/Type	**	Galvanized steel	ACSR Dog
1	Size	mm	7/3.15	6/4.72 Al + 7/1.57 steel
2	Configuration	**	One continuously To run horizontally on top of the Towers & conductors	One per phase
3	Overall diameter	mm	09.45	14.15
4	Unit weight	Kg/Km	426	394
5	Min. UTS	KN	58.4	32.41
6	Cross section area	mm ²	54.55	118.55
7	Modulus of elasticity	Kg/mm ²	1.933x10 ⁴	0.8055 x10 ⁴
8	Co-efficient of linear	/ °C	11.5x10 ⁻⁶	19.1x10 ⁻⁶

B Details of Silicone Rubber Insulator

1)	Size of discs	NA		
2)	Number of discs	Single unit		Double unit
	i) Suspension string	1 string		2x1 string
	ii) Tension string	1 string		2x1 string
3)	Description of string	Electro mechanical strength in KN	Length of insulator in mm	Approx. Weight in Kg.
	a) Single Suspension	90 KN	870	8.0
	b) Double Suspension	90 KN x 2	870	16 (8x2)
	c) Single Tension	90 KN	870	8.0

	d) Double Tension	90 KN x 2	870	16 (8x2)
4)	Creep age	31mm/KV		

C Insulator hardware:

- (i) Slipping Strength ACSR Dog
 - (a) Suspension Clamps : 8 - 15% of ultimate strength of conductor
 - (b) Tension Clamps : 95% of ultimate strength of conductor
- (ii) Minimum Failing Load ACSR Dog
 - (a) Suspension Fittings : 50% of ultimate strength of conductor
 - (b) Tension Fittings : 100% of U.T.S. of conductor
- (iii) Type
 - (a) Suspension Clamps : Forged Steel Hanger free center type without bolt only
 - (b) Tension Clamp : compression type
- (iv) Material : Aluminium/ steel
- (v) Ele. Resist. At 20⁰ C : ≤75% of measured resistance of equal length of conductor
- (vi) Ferrous Parts : Hot dip galvanized

12.0 STANDARD

12.0.1 The conductor shall conform to the following Indian/International standards, which shall mean latest versions & revisions, with amendments/changes adopted and published, unless specifically stated otherwise in specification.

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

Sr. No.	Indian Standard	Title	International Standard
1	IS:209-1992	Specification for zinc	BS:3436-1986
2	IS: 398-1982	Aluminium Conductors for Overhead Transmission Purposes	
3	IS:398-1990 Part-II	Aluminum Conductor Galvanized Steel Reinforced	

4	IS:398 (Part-IV)	Aluminium alloy stranded conductors (aluminium-magnesium-silicon type) - specification	
5	IS:398-1992 Part-V	Aluminum Conductor - Galvanized Steel Reinforced For Extra High Voltage (400 kV and above)	
6	IS : 1778-1980	Specification for Reels and Drums for Bare Conductors	
7	IS : 1521-1991	Method for Tensile Testing of Steel Wire	
8	IS:2629-1990	Recommended practice for Hot Dip Galvanizing of Iron & Steel	
9	IS:2633-1992	Method of testing Uniformity of Coating on Zinc Coated Articles	
10	IS:4826-1992	Galvanized coating on round steel wires	IEC:888-1987 BS:443-1969
11	IS:6745-1990	Methods of determination of weight of zinc coating of zinc coated Iron & Steel articles	BS:433-1969 ISO 1460-1973
12		Zinc coated steel wires for standard conductors	IEC:888-1987
13		Aluminium clad steel wire	IEC:61232
14		Method of measurement of resistivity of metallic materials	IEC:468
15		Thermal resistant Aluminium Alloy	IEC:62004
16		Carbon Fibre Composite core (CFCC/TS) for use in overhead electrical conductors	ASTM B987
17	IS : 9997-1988	Aluminium Alloy Redraw Rods for electrical purposes- Specification	
18		Aluminium clad steel wires for electrical purposes	IEC:1232
19		Standard for Calculating the Current Temperature Relationship of Bare Overhead Conductors	IEEE738
20		Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors	ASTM B498
21		Standard Specification for High-Strength Zinc Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced	ASTM B606
22		Standard Specification for Aluminum-Clad Steel Core Wire for Use in Overhead Electrical Aluminum Conductors	ASTM B502
23		Standard Specification for Thermostat Metal Sheet and Strip	ASTM B388

24		Standard Specification for Thermostat Component Alloys	ASTM B753
25		Standard Specification for Zinc-5% Aluminum Mischmetal Alloy-Coated Carbon Steel Wire	ASTM A856
26		Standard Specification for Steel Sheet Piling, Cold Formed, Light Gage	ASTM A857
27		Standard Specification for Aluminum 1350–H19 Wire for Electrical Purposes	ASTM B230
28		Standard Specification for Aluminum-Alloy 6201- T81 and 6201-T83 Wire for Electrical Purposes	ASTM B398
29		Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes	ASTM B609
30		Aluminium alloy wire for stranded conductors for overhead lines – Al 59 wire	SS 424 0813 & 814
31		Conductors for overhead lines. Aluminium conductors steel supported (ACSS)	BS EN 50540
32		Standard Specification for Heat Resistant Aluminum-Zirconium Alloy Wire for Electrical Purposes	ASTM B 941
33		standard Specification for Extra-High-Strength and Ultra-High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Overhead Electrical Conductors	ASTM B 957
34		Standard Specification for Zinc–5 % Aluminum Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)	ASTM B 802
35		Standard Specification for Extra-High-Strength and Ultra-High-Strength Class A Zinc–5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors	ASTM B 958
36		Standard Specification for Fiber Reinforced Aluminum Matrix Composite (AMC) Core Wire for Aluminum Conductors, Composite Reinforced (ACCR)	ASTM B 976
37		Standard Specification for Carbon Fiber Thermoset Polymer Matrix Composite Core (CFC) for use in Overhead Electrical Conductors	ASTM B987- 17 (latest amendment)

ANNEXURE - A

TEST PROCEDURES

1 Tests on Conductor

1.1 UTS TEST ON STRANDED CONDUCTOR

a) UTS Test on stranded conductor at room temperature

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5-meter length between fixing arrangement suitably compressed with dead end clamps proposed at either end. The load shall be increased at a steady rate up to (50%) of 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 a steady rate to (100%) of UTS 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 the value recorded.

b) UTS Test on stranded conductor at design temperature

UTS Test on stranded conductor shall be conducted as per (a) above keeping conductor temperature at design maximum temperature. Loading & Acceptance criteria as per cl. No. 1.2 (d) of this specification.

1.2 SURFACE CONDITION TEST

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

1.3 D.C. RESISTANCE TEST ON STRANDED CONDUCTOR

On a conductor sample of minimum 5 meter length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or using micro ohm meter of suitable accuracy by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 °C as per IS:398-(Part-IV)/(Part-V). The resistance corrected at 20 °C shall conform to the requirements of this specification.

1.4 CO-EFFICIENT OF LINEAR EXPANSION FOR CORE/CORE STRANDS

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 5 °C from 15 °C or laboratory ambient temperature whichever is higher (but not more than 30 °C) to maximum continuous operating temperature corresponding to rated current (minimum 550 Amperes) by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.5 BREAKING LOAD TEST ON ALUMINIUM / ALUMINIUM ALLOY & CORE STRANDS / COMPOSITE CORE AND DC RESISTANCE TEST ON ALUMINIUM / ALUMINIUM ALLOY WIRE

The above test shall be carried out as per IEC:888/889 or ASTM B987 as applicable and the results shall meet the requirements of the specification

1.6 WRAP TEST ON CORE STRAND

The wrap test on steel strands shall be meet the requirements of IEC:888. In case of aluminium clad core wire, the same shall be wrapped around a mandrel of diameter of five times that of the strand to form a helix of eight turns. The strands shall be unwrapped. No breakage of strand shall occur.

1.7 HEAT RESISTANCE TEST ON ALUMINIUM ALLOY WIRE

Breaking load test as per clause 1.5 above shall be carried out before and after heating the sample in uniform heat furnace at following temperature for one hour. The breaking strength of the wire after heating shall not be less than the 90% of the breaking strength before heating.

Maximum continuous operating temperature of conductor	Test Temperature
Up to 150 °C	230 °C (+5/-3 °C)
More than 150 °C & up to 210 °C	280 °C (+5/-3 °C)
More than 210 °C & up to 230 °C	400 °C (+5/-3 °C)

1.8 CHEMICAL ANALYSIS OF ALUMINIUM ALLOY AND CORE

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

1.9 VISUAL AND DIMENSIONAL CHECK ON DRUMS

The drums shall be visually and dimensionally checked to ensure that they conform to the approved drawings.

1.10 VISUAL CHECK FOR JOINTS, SCRATCHES ETC

Conductor drums shall be rewound in the presence of the purchaser representative. He should check for scratches, joints etc and that the

conductor generally conforms to the requirements of this specifications. 10% drums from each lot shall be rewound in the presence of purchaser representative.

1.11 DIMENSIONAL CHECK ON CORE STRANDS AND ALUMINIUM / ALUMINIUM ALLOY STRANDS

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

1.12 CHECK FOR LAY-RATIOS OF VARIOUS LAYERS

The lay-ratios of various layers shall be checked to ensure that they conform to the guaranteed values furnished by the Bidder.

1.13 PROCEDURE QUALIFICATION TEST ON WELDED ALUMINIUM ALLOY STRANDS

Two Aluminium Alloy wire shall be welded as per the approved 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 guaranteed breaking strength of the individual strand.

1.15 GALVANIZING TEST

The test procedure shall be as specified in IEC:888. The material shall conform to the requirements stated in this specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.16 TORSION AND ELONGATION TESTS ON CORE STRANDS

The test procedures shall be as per-6.3.3 & 6.3.2b of IEC-61232.

1.17 BENDING TEST ON ALUMINIUM CLAD CORE STRAND

A sample of Aluminium clad core strand measuring 30cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5cm and radius of bend 4.8mm. The bending should be first 90 degrees left and 90 degrees right. After this operation the strand should cut at the bending point. There should be no separation of core and Aluminium at the bending point after this operation.

1.18 COMPRESSION TEST ON ALUMINIUM CLAD STRAND

A sample of Aluminium clad core strand 10mm in length is to be compressed by a plate with a load of 3600kgs. The Aluminium and core strand should not break.

1.19 ALUMINIUM CONDUCTIVITY TEST ON ALUMINIUM CLAD STRAND

Resistivity test as per IEC:468 shall be conducted to confirm minimum conductivity as per specification requirement.

1.20 MINIMUM CONDUCTIVITY TEST ON ALUMINIUM / THERMAL RESISTANT ALUMINIUM ALLOY STRANDS

Resistivity test as per IEC:468/IEC:889 shall be conducted to confirm minimum conductivity as per specification requirement.

1.21 STRESS STRAIN TEST AT ELEVATED TEMPERATURE

Stress-strain test as per IEC:61089 shall be conducted keeping conductor temperature at designed maximum temperature. RTS for this test shall be considered as per cl. No. 1.2 (d) of this specification of the UTS guaranteed in the GTP.

1.22 HIGH TEMPERATURE ENDURANCE & CREEP TEST

Two conductor samples of length equal to at least 20 m. shall be strung at tension equal to 25% of conductor UTS. The conductor samples shall be subjected to tests as indicated below:

- 1) On one of the conductor samples, the conductor temperature shall be maintained at 20 °C for 1000 Hrs. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hours, 100 hours and subsequent every 100 hours up to 1000 hours' time period.
- 2) On other conductor sample, the conductor temperature shall be increased to designed maximum temperature in steps of 20°C and thermal elongation of the conductor sample shall be measured & recorded at each step. The temperature shall be held at each step for sufficient duration for stabilization of temperature. Further, the temperature of the conductor shall be maintained at maximum continuous operating temperature (± 10 °C) for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hours, 100 hours and subsequently every 100 hours up to 1000 hours' time period. After completion of the above, the core of the conductor sample shall be subjected to UTS test as mentioned above at clause 1.1 of Annexure A. The conductor core shall withstand a load equivalent to 95% of UTS. In case of polymer composite core conductor, the flexural strength & glass transition temperature of the core shall also be evaluated & the same shall not be degrade by more than 10 % over the value guaranteed in GTP but not less than designed conductor temperature. The supplier shall plot the thermal elongation with temperature.

The supplier shall furnish details of creep characteristic in respect of the conductor based on laboratory test and other laboratory investigations/experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1month, 6month, 1year, 10year & 20year creep at everyday tension & continuous designed temperature.

1.23 AXIAL IMPACT TEST

The conductor sample shall be suspended vertically and load applied by dropping a 650kg from an elevation of 4 meters above the sample. The impact velocity shall be not less than 8m/sec. with an initial pre-tension of 200kgs. The curve for load vs time shall be recorded and recorded load of failure for core shall not be less than UTS of core.

1.24 CRUSH STRENGTH TEST

A section of conductor is to be crushed between two six-inch steel plates. Load shall be held at 350Kgs for 1 minute and then released. Core strands should remain undamaged. Core strands shall be subsequently disassembled and tensile tested. Core strands shall exhibit full strength retention vis-a-vis guaranteed breaking strength of core wires (after stranding)

1.25 TORSIONAL DUCTILITY TEST

The conductor sample of 10-15 m. shall be loaded to 20% of UTS & then rotated in increasing steps of ± 180 degrees. The entire conductor shall withstand at least 16 such rotation & there shall not be any damage to Aluminium Alloy or core wires. In case of composite core conductor, after 4 rotations or after separation of Aluminium strands, the Aluminium wires shall be cut & removed from the conductor & exposed core shall be twisted & shall withstand up to 16 rotations.

1.26 SHEAVES TEST

The conductor sample of minimum length of 35 meter shall be tensioned at 20% of the UTS and shall be passed through pulleys having diameter of 32 times that of the conductor with angle of 20deg. between the pulleys. The conductor shall be passed over the pulleys 36 times a speed of 2m/sec. After this test UTS test on the conductor shall be carried out. Composite core shall be followed by visual examination and dye penetration test ASTM B987. (ASTMD5117)

1.27 AGEING TEST ON FILER

The test shall be done in accordance with grease drop point test method.

1.28 AEOLIAN VIBRATION TEST

The test shall be performed with hardware proposed for use. The assembly shall be loaded to 25% of UTS on span not less than 30 meters. Conductor tension shall be measured using standard means. Conductor tension shall be maintained constant using some means. The assembly shall be supported with suspension assembly to have sag angle 1.5 ± 0.5 degrees. Shaker shall be used to excite assembly in vertical plane. The test shall be carried out at one or more resonance frequencies. The amplitude at the antinode point shall be one third of conductor diameter. The assembly shall be vibrated for not less than 10 million cycle without

any failure. After the test, assembly shall be subjected to UTS test as per cl. 1.1 & shall retain value 95% min.

1.29 TEMPERATURE CYCLE TEST

The test shall be performed with hardware proposed for use. Minimum clear length of conductor between dead ends shall be not less than 10 meters. The assembly shall be strung at 20% of conductor UTS.

- (a) Conductor temperature shall be increased from ambient temperature to designed maximum temperature($\pm 5^{\circ}\text{C}$) by passing of current, maintained for min. 10 minutes. & then allowed to cool up to AT. Min. 100 such cycles shall be applied. On completion of 100 cycles, assembly shall be mechanically loaded to 70% of UTS@AT withhold period of 24 Hrs.
- (b) Procedure (a) above shall be repeated 5 times.
- (c) During the test, temperature of connectors, conductor & resistance are recorded.
- (d) Assembly shall be subjected to UTS test as per 1.1 of this Ann. – A.
- (e) Assembly is considered meeting the requirement if no failure occurs during test & min. 95% of UTS value is recorded.
- (f) In case of polymer composite core, the flexural strength should not degrade by more than 10% & glass transition temperature shall not degrade by more than 10% after the test than the value specified in GTP. However, value of Tg in no case shall be less than designed conductor temperature.

1.30 STRAND BRITTLE FRACTURE TEST (BFRT) TEST FOR POLYMER COMPOSITE CORE

The sample shall be tensioned to approx. 25% of UTS with simultaneous application of 1N-HNO₃ acid directly in contact with naked polymer composite core. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm. The rod shall withstand 80% of SML for 96 hours.

1.31 FLEXURAL STRENGTH OF POLYMER COMPOSITE CORE

Test method shall be as per ASTM D7264, ASTM D4475 or ISO 14125. The strength value derived as average of five (5) results shall not be less than the specified value in GTP.

1.32 GLASS TRANSITION TEMPERATURE FOR POLYMER COMPOSITE CORE

Test method shall be as per ASTM B987.

Offered conductor with maximum continuous operating temperature less than 180°C, achieved value of Tg shall be not less than 205 °C.

For offered conductor having maximum continuous operating temperature equal or more than 180°C, achieved value of Tg shall be designed maximum continuous operating temperature of offered conductor + 25°C.

1.33 TORSION AND ELONGATION TEST FOR COMPOSITE CORE

- a) Torsion Test – Sample length not less than 200 times core diameter shall be gripped at two ends. By moving of one end, core shall be subjected to 360° twist, hold for 2 minutes and untwist. No damage to core shall be noticed visually. Core subjected to tensile load test & value observed shall be RTS min.
- b) Elongation Test – Core shall be loaded gradually up to tensile strength of core. Elongation shall be measured using extensometer. Elongation value achieved shall be not less than guaranteed in GTP.

1.34 BENDING TEST FOR COMPOSITE CORE

Test method shall be as per ASTM B987. However, for test after stranding, the value of cylindrical mandrel diameter shall be (a) 60 times the diameter of CFC for high strength grade & (b) 70 times the diameter of CFC for extra high strength grade.

1.35 TEMPERATURE RISE TEST (DEAD END/RS/MSJ)

The test shall be performed with Dead end/Repair sleeve/MSJ proposed for use. Minimum clear length of conductor between dead end/RS/MSJ shall be not less than 2 meters. The assembly shall be strung at 25% of conductor UTS & tension shall be maintained constant using some means. Arrangement shall be made for temperature measurement of each article & conductor. The AC current of 550 Amp. shall be passed through the assembly for the period sufficient for temperature to rise & reach constant value (for practical purpose, this condition is attained when the variation does not exceed 1°C per hour).

Temperature value on surface of the articles shall be less than that of the conductor.

1.36 HEATING CYCLE TEST (DEAD END/RS/MSJ)

The test shall be performed with Dead end/Repair sleeve/MSJ proposed for use in general accordance with provisions of IS:2486 with following changes,

- 1) Temperature of conductor during each cycle - 40°C above designed maximum operating temperature of conductor, but not exceed emergency temperature of conductor.
- 2) Number of cycles – 100.
- 3) Slip strength test shall be carried out after Heating cycle test.
- 4) In case the proposed hardware and accessories are change in the event of order, bidder has to carry out all above type tests, free of cost to GETCO, before commencement of supply, without affecting delivery schedule. The confirmation for the same shall be submitted along with technical bid.

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2.	Address of Manufacturer works from which conductor is offered		
3.	Name of the conductor		
4.	Construction of conductor/ Designation of conductor as per IEC:61089 along with sectional view.		
5.	PARTICULARS OF RAW MATERIALS		
5.1	Outer Layers a) Type of Aluminum/Alloy b) Applicable standard c) Minimum purity of Aluminium d) Chemical composition of Aluminum / Alloy i) ----- ii) ----- iii) ----- iv) ----- v) -----	 % % % % %	
5.2	Inner Core a) Material of core b) Applicable standard c) Chemical composition of core i) ----- ii) ----- iii) ----- iv) ----- v) ----- vi) -----	 % % % % % %	
5.3	Zinc used for galvanization of inner core (if applicable) a) Minimum purity of zinc	 %	
6.	CONDUCTOR STRANDS (AFTER STRANDING)		

6.1	Number of conductor layers	Nos.	
6.2	Diameter & number of strands layer wise a) Nominal b) Maximum c) Minimum	mm mm mm	
6.3	Minimum Breaking load of strand a) Before stranding b) After stranding	KN KN	
6.4	Resistance of 1m. length of strand at 20 deg. C.	Ohm	
6.5	Cross section area	Sq. mm.	
6.6	Linear mass of Aluminium/Aluminium Alloy	Kg/km.	
6.7	Final modulus of elasticity	Kg/sq. mtr.	
6.8	Final co-efficient of linear expansion	per °C	
7	INNER CORE STRANDS/ INNER CORE (AFTER STRANDING)		
7.1	Number of layers in inner core & applicable standard		
7.2	Diameter & number of strands layer wise a) Nominal b) Maximum c) Minimum	mm mm mm	
7.3	Minimum Breaking load of strand/Flexural strength of composite Core a) Before stranding (for strand) b) After stranding (for strand) c) Total core	KN KN KN	
7.4	Galvanizing (if applicable) a) Minimum mass of zinc coating per sq. m. Of uncoated wire surface. b) Minimum number of one minute dips that the galvanized strand can withstand in the standard preece test c) Min. no. of twists which a single strand shall withstand during torsion test for a length equal to 100times dia. of wire after stranding.	gm Nos. Nos.	

7.5	Linear mass of core	Kg/km.	
7.6	Cross section area	Sq. mm.	
7.7	Modulus of Elasticity	Kg / Sq. mtr.	
7.8	Coefficient of linear expansion	per °C	
7.9	Resistance of 1m. length of strand at 20 deg. C. (if considered in offer)	Ohm	
7.10	Aluminium cladding of core (if applicable) & applicable standard a) Thickness of cladding (Min./Max.) b) Min. number of twists applicable for Torsion test c) Min. % Elongation	mm. nos. %	
7.11	Filler (if applicable) a) Type of filler b) Mass of filler	--- Kg/km.	
7.12	Max. tensile load applicable on core for sag-tension calculation	KN	
7.13	Bending radius permissible	mm.	
7.14	For CFC core – a) Grade of CFC core b) Rated Glass Transition Temperature (Tg)		
8	COMPLETE HTLS CONDUCTOR		
8.1	UTS of Conductor @ Ambient Temperature (AT) @ Designed maximum operating temperature	KN	
8.2	Lay ratio and direction of conductor a) 1st Layer (outer most layer) b) 2 nd Layer c) 3 rd Layer d) 4 th Layer		Maximum Minimum
8.3	Cross section area a) whole conductor b) Aluminium/alloy	Sq. mm.	
8.4	Overall diameter of conductor	mm.	

8.5	Linear mass of the Conductor a) Standard b) Minimum c) Maximum	Kg/km Kg/km Kg/km	
8.6	Maximum permissible conductor temperature for continuous operation	°C	
8.6.1	Maximum current carrying capacity of conductor based on maximum permissible conductor temperature for continuous operation (under Ambient conditions detailed in Technical Specification)	Amp.	
8.7	Maximum permissible conductor temperature for short term operation	°C	
8.7.1	Permissible duration of above short term operation	Minutes	
8.9	Designed current carrying capacity (i.e. 550 Amps.) & corresponding temperature of offered conductor.		
8.9.1	Conductor maximum Ampere capacity offered without violating Sag-Tension requirement and having steady state temperature not more than 210 °C (under Ambient conditions detailed in Technical Specification)	Amp.	
8.10	DC resistance of conductor at 20°C	Ohm/km	
8.11	Conductor Temperature co-efficient of resistance		
8.12	A. C. Resistance for condition 8.9.1 above.	Ohm/km	
8.13	Corresponding to Ampere capacity of 450 Amp a) conductor temperature b) A.C. Resistance c) detailed calculation for (b) attached	°C Ohm/km Yes	
8.14	Corresponding to Ampere capacity of 550 Amp a) conductor temperature b) A.C. Resistance c) detailed calculation for (b) attached d) Modulus of Elasticity e) Coefficient of linear expansion f) Sag Tension Calculation (for Tower ruling span 260 mtr.) attached g) Sag Tension Calculation	°C Ohm/km Yes	

	(for H frame structure ruling span 190 mtr.) attached			
8.15	Details of Creep characteristic for HTLS conductor enclosed (as per Technical Specification)	Yes/No		
8.16	Final Modulus of Elasticity i) Up to transition temperature Above transition temperature	Kg / Sq. mtr.		
8.17	Coefficient of linear expansion – a) Up to transition temperature b) Above transition temperature	per deg. C.		
8.18	Sag Tension Calculation (for ruling span of 260 meters for Tower structure & 190 meters for H frame structure)		260 meters for Tower structure	190 meters for H frame structure
8.18.1	Sag Tension Calculation enclosed	Yes/No		
8.18.2	Maximum conductor temperature offered, without violating Sag-Tension requirement	°C		
8.18.3	Tension at 32 °C & no wind	Kg		
8.18.4	Sag & Tension at maximum continuous operating temperature (corresponding to 8.18.2 above)	Meters & Kgs		
8.18.5	<i>Sag-Tension details</i>			
i)	Tension at 32 °C & full wind pressure (45 kg/m ²)	Kg		
ii)	Tension at 0 °C & 2/3 wind pressure (30 kg/m ²)	Kg		
iii)	Sag & Tension at 0 °C & No wind pressure			
8.19	Tension at knee point temperature	Kg.		
8.20	Standard length of conductor	KM		
8.20	Tolerance on standard length of conductor	%		
8.21	Maximum length of conductor that can be offered as single length	KM		
9.0	Details of Drum marking as per Cl. No. 8 of specification	Yes	With separate sheet	
10.0	Hardware & Accessories as per specifications	Yes		
11.0	Hardware & Accessories suitable for conductor temperature maximum continuous & emergency operation	Yes		

Date: (Signature).....
Place: (Printed Name).....
(Designation).....
(Common Seal).....

SECTION-II

EXECUTION OF WORK

1. SCOPE:

- 1.1 The erection works covered under this section consist of
- a. Dismantling of existing ACSR Dog conductor, hardware & insulators from line and shifting it to bidder's store, at bidder's risk and cost. GETCO shall not be responsible for any damage, loss etc. for any of the removed material.
 - b. Transportation, delivery of HTLS conductor, hardware, SRI etc and transportation to erection site and keeping in safe custody.
 - c. Insurance of material during storage-cum-erection.
 - d. Distribution of materials at erection site,
 - e. Stringing of HTLS conductor up to sub-station gantries at both ends with the help of tensioner and puller machine preferably.
 - f. Bidder shall Guarantee of all the activities carried out from (a) to (e).
 - g. FQP for carrying out of all above activities shall be submitted with Technical bid.
 - h. Other items not specifically mentioned in this Specification and are required for the successful erection, testing and commissioning of the transmission line, shall be considered & provided.
- 1.2 All works shall be carried out in accordance with the applicable standards, Indian Electricity Act and Rules amended up to date.
- 1.3 All the erection tools including any special tools required during execution of work shall be arranged by the Bidder at his own cost. The Bidder shall be responsible for any damage to and / or loss of his erection tools.
- 1.4 Quantities given in the Schedule of erection in price Bid are to be executed by the Bidder at the rates accepted by the GETCO in the A/T. In case of any deviation resulting into an increase in which event the field officer shall obtain prior approval of the Corporate Office and excess quantity shall be paid only at the accepted rate of the A / T.
- 1.5 The erection work beyond contractual ceiling amount shall be done only after approval from the GETCO.

2.0 ACCESS TO LOCATIONS:

- 2.1 It will be the Bidders sole responsibility to take the materials up to the location. Any path way, temporary road, temporary bridge required will have to be provided by the Bidder at his own cost. If, for any reasons the above is not feasible, the Bidder at his own cost shall have to arrange transportation by head loads.

3.0 STRINGING:-

The stringing work should be carried with the help of tensioner and puller machine preferably but as per site condition. Stringing work shall mean, the activities of fixing of insulator and insulator hardware, paying, jointing, tensioning, clamping with armour-rod, providing dampers, repairing of conductors (if any) and fixing the conductor at tension hardware etc.

- 3.1 Stringing of conductor shall be done up to sub-station gantries at both ends.
- 3.2 The stringing work should be planned in such a manner in consultation with the Engineer in charge of the work that minimum shut down of power line crossings are required.
- 3.3 Before commencing of stringing work, Bidder must obtain approval of sag tension charts (these shall have to be submitted by the Bidder) showing final sag and tension for various temperature and spans.
- 3.5 The Bidder shall be responsible and will take care of proper handling of conductor drums. Sufficient numbers of aluminum snatch blocks shall be used for paying out the conductors. Necessary precautions shall be taken to avoid conductor rubbing on the ground by providing adequate ground roller, rollers on supports. Additional rollers shall also be provided to cross thorny hedges, footing and other obstructions to avoid scratching of conductor. The conductor shall be made to sag correctly as per stringing charts, before they are finally transferred to the hardware for conductors. No joint allowed in Gap type conductor, no joint should be made at less than 30 meters from the tower / H frame end and no joint shall be permitted in Railway, River, road and other important crossings spans. There shall not be more than one joint in a section of each conductor. The sag shall be adjusted to suit the sag indicated against actual temperature for an individual span. The thermometer shall be provided at the conductor point during the stringing work. Dynamometers shall be used in tensioning the conductors. All conductors shall be stressed to their maximum working load at the time of stringing, as per approved stringing charts.
- 3.6 The minimum clearance between the lowest point of conductor and ground shall not be less than required as per rules. All compression joints should be carefully made and a record of initial and final lengths of the joints jointly signed by Bidder's and GETCO representatives shall be maintained. Check for sag should also be made at intervals when conductors are drawn up. Over stressing, causing damage to towers /

structure must be avoided. Care should be exercised not to over tension the conductor.

To avoid contact with the ground or any object above ground level the conductors shall be pulled by the controlled tension methods using neoprene lined double pulled wheel type tension stringing equipment. The equipment shall be capable continuous of maintaining continuous tension of not less than of 5000 kg. per conductor

- 3.7 During the time the conductor is on the stringing sheaves before sagging-in, it shall be ensured that the conductor is not damaged due to wind, vibration, vehicles or other causes. Scaffolding should be used to cross the roads and Railway Crossing for minimum interruption to traffic.
- 3.8 The conductor shall be pulled up to desired sag and left in serial stringing sheaves for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before clipping in and transferring the conductors from the serial stringing sheaves to the suspension clamps.
- 3.10 The stringing sheaves, when suspended on the transmission structure for sagging, shall be so adjusted that the conductor will be on the sheaves at the same height as the suspension clamp to which it is to be secured.
- 3.12 All the line conductors shall be terminated at sub-station structures whose details shall be furnished by the GETCO at the appropriate time. The contractor shall fix strain insulators on the sub-station structures.
- 3.13 Armour rods and vibration dampers shall be fitted at each suspension tower / H frame before final clamping of conductor with Insulator strings. Vibration damper shall be fitted at each tension tower / location after final clamping of conductor with insulator strings. Vibration dampers are to be fixed in correct vertical position in relation to conductor. All the joints of conductors shall be made with the best workmanship and shall be perfectly straight and having maximum possible strength.
- 3.14 Proper guys shall be provided to counter balance the paving out tension of conductor/ground wire at the tension locations, to avoid damage to tower / structures and/or accident.
- 3.15 Any modification required in existing structure for accommodation of Suspension/Tension assembly for stringing/erection work will require prior approval & shall be considered in bidder's account & no extra cost shall be paid by GETCO.

4.0 FIELD QUALITY PLAN

Bidder shall invariably submit the FQP along with Technical Bid for erection of line including all the activities such as dismantling, stringing etc. with detailed check list to be referred.

5.0 GENERAL:

- 5.1 The Bidder shall ensure that at the end of each sub-activity the surplus material is immediately removed from the work-site to avoid loss and injury to the public.