NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)
Project Management Directorate

TRANSMISSION LINE UPGRADING PROJECT

A component of
Electricity Grid Modernization Project

BIDDING DOCUMENT
FOR

Design, Supply, Installation and Commissioning of 132kV Transmission Line Conductor Upgrading
(Procurement of Plant)

Single-Stage, Two-Envelope
Bidding Procedure

Issued on:	**10 August 2020**
Invitation for Bids No.:	**PMD/EGMP/TLUP-077/78-01**
OCB No.:	**PMD/EGMP/TLUP-077/78-01**
Employer:	**Nepal Electricity Authority**
Country:	**Nepal**

VOLUME –II OF III
August 2020

Transmission Line upgrading Project
Project Management Directorate
NEA Training Centre Complex, Kharipati
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CHAPTER 1-Project Specification Requirement

1.0 GENERAL

1.1.1 The primary objective of Nepal Electricity Authority (NEA) is to generate, transmit and distribute adequate, reliable and affordable power by planning, constructing, operating and maintaining all generation, transmission and distribution facilities in Nepal's power system both interconnected and isolated.

1.1.2 NEA is the Executing Agency.

1.2 INTENT OF SPECIFICATION

1.2.1 This specification covers the execution of Upgradation of following lines:

a. Suichatar - Matatirtha ~5 Km DC ACSR Bear
b. Suichatar - Balaju ~4 Km SC ACSR Duck
c. Suichatar - Teku ~4.5 Km DC ACSR Bear
e. Pathlaiya – Dhalkebar ~102 Km DC ACSR Bear
f. Kushaha Duhabi ~28 Km DC (string of this line on one Ckt) ACSR Bear
g. with upgrading of CT, Connectors and accessories

1.2.2 It is the intent of this specification to describe primary features, materials, and design and performance requirements and to establish minimum standards for the work. The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.

2.0 SCOPE

2.1 The broad scope of this specification covers the following Sub Transmission line and Capacitor bank along with other equipment.

2.1.1 Upgradation of a Transmission Line.

I. De-stringing of existing Conductor including dismantling of associated insulators of the existing ACSR conductor as mentioned above, Rerolling into a Drum and storing the dismantled conductor in NEA Local store or any other place designated by the Employer. The supply of the drums, if required shall be in the scope of the Contractors without any cost to NEA.

II. Supply of HTLS conductor along with all necessary accessories, hardware and fittings completely compatible for use in stringing of proposed HTLS conductor by replacing the existing one.

III. Supply of Insulators and hardware as much as the quantity required compensating the punctured and ageing insulators and hardware in the existing line. The insulators & hardware fittings (excluding clamps) if in good condition to be re-used.

IV. Stringing of the HTLS conductor along with insulator, hardware fittings and other accessories required complete and commissioning of the line without

changing/modification of existing transmission line structures and foundations.

V. Site Inspection; Survey & profiling of existing line route using Total stations, verification of availability of statutory electrical clearances using PLS-CADD software.

VI. The entire quantity of dismantled line materials viz. conductor, hardware fittings, insulators & conductor accessories removed from the existing line is envisaged for re-use/ utilization by the employer in other projects. Proper handling and safety of the conductor, insulator, fittings and accessories during de-stringing, storage at site, measurement of conductor lengths, rewinding on drums at site and safe transportation to employers designated stores along the transmission line shall be included in the scope of work.

VII. The 132kV Transmission line from Suichatar to Balaju is strung with ACSR Duck, but the tap span of 300-400 m is strung with ACSR Bear. So, Contractor is require to study the line and transmission line tower, so that the tower can be loaded and installed with ACSR Duck.

VIII. The scope also includes supply, delivery, installation and commissioning of Current Transformers in the AIS bays and GIS Bay (at Balaju) is required to be replaced with higher rated CT.

IX. The scope includes supply, delivery and installation of all hardware and connectors required for transmission line and replacement of existing conductors of the switchyard in the respective line bays.

X. The scope includes supply, delivery and installation of 132kV XLPE 1000 sq.mm Cu cable with all termination for termination into existing ALSTOM make GIS including all accessories complete at Balaju Substation.

XI. Currently, the busbar protection at the substations are rated for 600/1A. The busbar relays used in most substations are static type. Therefore, the integration arrangement shall be provided to integrate the new HTLS line with CT into the busbar protection. The bidder is required to include all such cost in the price quoted for installation of Current Transformer and conductors.

Lattice Type Tower:

I. The Contractor will be fully responsible for the safety of the existing line towers, and shall warrantee the safety of the structure for whole period of the contract including the defect liability period. The contractor shall carry out the study of suitability of existing tower structure for the offered conductor. If available, the Employer may provide the drawing of existing structures to the successful bidder.

II. The contractor shall supply and install the missing members of the tower, without altering the quality and dimensions of existing used members.

2.2.1.1 Design, engineering, manufacture, testing, supply on site basis including transportation & insurance, storage at site of mandatory spares.

2.2.1.2 ***Civil Works*** *- The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor:-*

a) Cable trenches modification and construction if required along with covers inside Control buildings and outdoor as required.

b) The existing CT structure shall be reused, after suitable modification. The cost for such work shall be included in the cost of installation.

2.3 The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy. Before proceeding with the construction work of the Sub-stations and line, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Employer shall endeavor to provide the information, it shall not be binding for the Employer to provide the same. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction / installation work shall be supplied by the Contractor. The cement and steel shall also be supplied by the Contractor.

The complete design **(unless specified otherwise in specification elsewhere)** and detailed engineering shall be done by the Contractor based on conceptual tender drawings. Drawings for civil works enclosed with tender drawings are for information only. However civil drawings shall be developed by the contractor as per his design.

2.4 The Contractor shall also be responsible for the overall co-ordination with internal / external agencies, project management, training of Employer's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

2.5 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the line and substation are deemed to be included in the scope of the specification unless specifically excluded.

2.6 Employer has standardized its technical specification for various equipments and works for different voltage levels. Items, which are not applicable for the scope of this package as per schedule of quantities described in BPS, the technical specification for such items should not be referred to.

2.7 The Employer shall arrange shut down of one circuit at a time and the other circuit shall be kept under charged condition. The contractor shall de-string the existing conductor and restring the circuit with the HTLS conductor section by section and restore the line in original conditions as per program finalized in co-ordination with site. Appropriate safety measures along with necessary safety tools and equipment to carry out de-stringing and stringing operations under the above conditions including mechanical/ structural safety of the towers, shall be the responsibility of the contractor. Necessary calculations shall be carried out by the contractor to ensure that by replacing the existing ACSR conductor with the HTLS conductor offered, the loadings on the towers due to conductor tensions as well as loads on account of the reconductoring activities shall be within specified limits. These calculations shall be submitted by the contractor during detailed engineering.

2.8 For the critical lines where shutdown may not be availed easily, the bidder may use the ERT system for installation of HTLS conductor. Such ERT tower will be provided by the Employer but the installation of tower and reconductoring shall be done by

the Contractor without any extra cost to employer. The bidder is required to include such cost in the respective items in the BPS.

2.9 The scope of the package shall include re-conductoring works at site as per the approved procedure during the entire period of stringing. The stringing works including installation of HTLS conductor & its fittings & accessories shall be supervised by a Manufacturer's team of engineers / supervisory staff/ workmen already experienced in stringing work associated with the type of HTLS conductor being supplied. In addition the Contractor shall involve and train the Technical personnel from the Employer or NEA during the installation.

3.0 SPECIFIC EXCLUSIONS

The following items of work are specifically excluded from the scope of the specifications for all substations:

(a) Employer's site office

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Location of the Substations –

Pathlaiya, Chandranigahpur, Dhalkebar, Inerwa, Kusaha, Duhabi Substation are located along East West Highway.

Similarly, Balaju, Suichatar and Teku substation is in Kathmandu District.

4.2 Meteorological data :-

a) Altitude above sea level :

400m from MSL for all terai substation, 1440m for substation in kathmandu

b) Ambient Air Temperature :

45ºC(max)/ 0 ºC(min)

c) Average Humidity (in %) :

95 (max), 40(min)

d) The substation locations are lying in the wind speed Zone 4 i.e. 47m/s.

e) Seismic Requirement for Substations: 0.5g (Horizontal peak acceleration value).

However, for design purposes, ambient temperature should be considered as 50 degree centigrade and Relative humidity 100% for both the substation.

4.3 The fault level of all equipment to be supplied under present scope shall be as indicated below:

S.NO.	Voltage Level	Fault Level
1	132 kV / 66kV	31.5kA for 1 Sec

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules.

All equipments/items and civil works for which bill of quantity has been indicated in BPS (Bid price Schedules) shall be payable on unit rate basis/quoted rate basis. During actual execution, any variation in such quantities shall be payable as per relevant clauses incorporated in Letter of award.

Wherever the quantities of items/works are indicated in LS/Lot/Set, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules. For erection hardware items, Bidders shall estimate the total requirement of the works and indicate module-wise lump sum price bay wise and include the same in relevant Bid price schedules. For module identification, Bidder may refer typical drawings enclosed with the specifications. Any material/works for the modules not specifically mentioned in the description in BPS, as may be required shall be deemed to be included in the module itself.

The detailed bill of quantities of the mandatory spares is as per BPS.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Employer.

6.0 BASIC REFERENCE DRAWINGS

6.1 Single line diagram and general arrangements are enclosed with the bid documents for reference, which shall be further engineered by the bidder.

6.2 The reference drawings, which form a part of the specifications, are given. The bidder shall maintain the overall dimensions of the substation, phase to earth clearance, phase to phase clearance and sectional clearances.

The enclosed drawings give the basic scheme, layout of substation, substation buildings, associated services etc. In case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from Employer.

7.0 ORDER OF PRECEDENCE OF DIFFERENT PARTS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification shall consist of following parts and they should be read in conjunction with each other.

1.	Chapter 1 : Project Specific Requirement	
2.	Chapter 2: General Technical Requirement (GTR)	
3.	Chapter .3: Instrument Transformer	
4.	Chapter .4: HTLS Conductor	
5.	Chapter 5: Power and Control Cable	
6.	Chapter 6: HTLS Clamps and fittings	
7.	Chapter 7: Hot line maintenance Tools	
8.	Chapter 8: HTLS installation	
9.	Chapter 9: Civil Works	
10.	Chapter 10: EHV Power Cables	
11.	Chapter 11: Technical Data Sheet	

In case of any discrepancy between Chapter 1-PSR, Chapter 2-GTR and other technical specifications on scope of works, Chapter 1 - PSR shall prevail over all other chapters.

In case of any discrepancy between Chapter 2-GTR and individual chapters for various equipments, requirement of individual equipment chapter shall prevail.

8.0 SPARES

Mandatory Spares

The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of BPS and shall be considered for evaluation of bid. It shall not be binding on the Employer to procure all of these mandatory spares.

The bidder is clarified that no mandatory spares shall be used during the commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for commissioning purpose shall be taken back by the contractor.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the supply of all special tools and tackles required for operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the BPS. In addition to this the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of these equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

10.0 FACILITIES TO BE PROVIDED BY THE EMPLOYER

10.1 Employer shall make available the auxiliary HT power supply from NEA on chargeable basis at a single point in the Sub-station. The prevailing energy rates shall be applicable. All further distribution from the same for construction and permanent auxiliary supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.

10.2 Employer shall make available construction water supply at a single point in the substation. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

11.0 SPECIFIC REQUIREMENT

11.1 The Bidders are advised to visit Sub-stations site and acquaint themselves with existing facilities, the topography, infrastructure, etc.

11.2 The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Employer.

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of the Contractor.

11.3 Erection, testing and commissioning of HTLS Conductors shall be done by the contractors under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.#

11.4 The Frequency range for the earthquake spectra shall be as per IEC-62271-300 for Circuit Breaker.

11.5 Transmission line side insulator String (including Hardware) i.e. tension insulator on the line side of the takeoff gantry for 132 & 66 KV lines termination is under the present scope of specification.

11.8 LIST OF PREFERED SHORTLISTED MAKE/MANUFACTURER: (N/A)

"It is preferred that the equipment be supplied from the manufacturers listed in **ANNEXURE-II** for mentioned equipments/items.
The bidders may offer equipment/brands other than those listed in **ANNEXURE-II**, that are better or equivalent with regard to quality and performance substantiated with appropriate documents.

11.9 In specification all parameters mentioned are corresponding to less than 1000 Mts MSL.

12.0 PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

(i) Pre commissioning**:** As per relevant Chapters

(ii) Commissioning : Charging of the Facilities at rated voltage

Further, wherever appearing in these specifications, the words – 'commissioning checks', 'installation checks', 'site tests', 'performance guarantee tests for fire protection system', are to be considered as 'pre commissioning checks'.

(iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72 (Seventy two) hours continuously. In case of interruption due to problem / failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72 (Seventy two) hours period start after such rectification.

(iv) Completion : Upon successful completion of Trial-run.

'Guarantee Test(s)' and/or 'Functional Guarantees' are applicable only for High Temperature Low Sag as specified in Chapter-'High Temperature Low Sag'

Note: The Contractor shall do the necessary calculations for relay setting required for Pre-commissioning, Commissioning, Trial-run and Completion for the substations under the scope of this Contract. All the relay setting calculations required for the substations (in this scope) with related to Integrated Nepal Power System (INPS) shall be done by the Contractor.

13. Social Safeguard and Environment and Management Plan

The Contractor shall prepare Social Safeguard and Environment Management Plan to be implemented during execution of the Project. The following major activities shall be considered:

Labour recruitment: The Contractor shall give preference to the use of local and regional labour provided that it is consistent with the requirement of good workmanship based on the need of the project.

Staff training and sensitization: At the beginning of works the Contractor shall organize training and awareness-raising workshops intended for his teams to improve their understanding to prevent or minimize the impact of their activities on the environmental and social aspects to promote good relations with the local people.

Among others topics addressed should also include the following:

Likely environmental impact of works, good practices, preventive and corrective measures to be adopted; Rules and procedures for waste management at

construction sites; Safety risks associated with the works, and preventive attitude to adopt; First aid and what to do in case of accident; General standards concerning relations with the local people; Risks and prevention of sexually transmitted diseases. The training and awareness sessions should be organized whenever new workers are recruited. Feedback and training during the works and after the monitoring and control exercise, additional training and awareness activities may be necessary if it happens that the previous sessions had failed to achieve the desired effects.

Demarcation, signing and closing of worksites: Setting up warning signs at worksites to limit the access of persons, machinery and equipment into construction areas and confine the works related to the construction process to the allocated areas.

Access to private property: Contractor shall coordinate with the Employer for the access of private property, if required. Crossing of private property shall be subject to prior notification to the owners and conducted in such a manner as to minimize damage to crops or other property on the land.

Discovery of relics of historical and archaeological importance: In the unlikely event of discovery of historical relics, the works will be interrupted temporarily and the discovery notified to the local authority responsible for cultural heritage in order to determine the appropriate course of action.

Restoration of sites: After the infrastructure has been put in place and the construction sites and equipment depots cleared, the sites should be rehabilitated without undue delay in the original condition or better, unless there are plans for future use requiring that such sites be left in their current state.

Storage and handling of hazardous substances: Hazardous substances such as oils, lubricants or other hazardous substances likely to contaminate surface or ground water and soil should be stored or handled in premises specially designed for this purpose, in order to protect the environment and human health. If the handling of oils and fuels is necessary, demarcated and waterproofed areas that may contain any spills must be provided.

Maintenance of equipment: Maintenance of equipment should not be performed immediately at the work site as far as practicable.

Air quality and noise pollution: Care must be taken to ensure that all equipment, machinery and vehicles used for works and equipped with a combustion engine are in good working conditions to limit undesired emission of air pollutants and noise nuisance.

Construction works that could cause noise should be performed only outside normal rest hours near residential areas. When noisy works must be carried out close to schools or other noise-sensitive receptors, working hours should be so scheduled as to limit the nuisance caused.

It is forbidden to burn in the open any kind of household, industrial and toxic or hazardous waste, project induced waste and all types of scrap metal.

Transportation of equipment: Equipment for overhead lines will be transported by existing roads up to the point nearest to the installation site. Thereafter, it will be transported manually to the site without opening up any access paths. When crossing the land between roads and installation sites, care should be taken not to damage vegetation, agricultural land or any other property on the land.

Erection of Poles: Vegetation should be removed only in so far as strictly necessary for opening foundations for poles and for such other operations as may be performed at each spot.

When erecting the poles, necessary precaution should be taken to minimize the impact on adjacent areas.

Unrolling of cables: When cables are being unrolled, necessary precaution should be taken to prevent impact on tree vegetation, crops and other property on the land crossed by the cables. If necessary, temporary gantry-like structures should be used to facilitate crossings.

Restoration or damage compensation: If the works on private property cause damage to crops or other property, the Contractor must proceed with the repair of such damage or, where this solution is not sustainable, with the fair and timely compensation of the owners.

Management of material from digging trenches: Uncontaminated soil from excavations will be reused to backfill the trenches of underground lines. Any such soil that cannot be reused is deemed to be waste and must be conveyed to its final destination. Its uncontrolled spread is prohibited in places where it could cause damage. Minimum dust on ground policy is to be used to prevent dust associated pollution after the construction.

Sensitive Areas: From an environmental point of view, wetlands, swamps, and bogs should be avoided when planning underground cable as these habitats may suffer severe or even irreparable harm. Also sensitive water flows and archaeological sites should factor in route planning process.

Disruption of pedestrian and automobile traffic: When trenches are opened along the road, they should be barricaded, fenced off and warning signs placed at the worksites to ensure the safety of pedestrians, motorists and the staff carrying out the works.

There must be continued access to land and buildings located along trenches through installation of secure and clearly signalled temporary structures. This also applies to trenches that cut across the roadways.

Upon completion of the underground cable installation, the trenches should be resealed and the pavement repaired as soon as possible, to ensure its durability and the absence of irregularities that may present a traffic hazard.

Regular sprinkling of water shall be done to avoid dust pollution till the roads/sidewalks are reinstated.

Public information on electrical hazards, behaviour and preventive measures: Before switching on the infrastructure installed as part of the project, the neighbouring populations should be informed in good time, through public meetings and/or distribution of information leaflets. The information provided to them should focus on the electrical hazards associated with the infrastructure and the behaviour that would allow them to avert such hazards. The population of these areas should be particularly targeted.

Unanticipated Impacts identified during the construction should be mitigated in coordination with environmental and social monitors employed by Contractor, Consultant and Government separately.

14. Safety of Personnel

The maximum safety consistent with good erection practices in the case of work above ground must be afforded to personnel directly engaged under this contract. Reasonable measures shall be taken to afford adequate protection against material falling from a higher level onto personnel below.

CHAPTER 2- GENERAL TECHNICAL REQUIREMENT

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1.0 FOREWORD

1.1 The provisions under this chapter are intended to supplement general requirements for the materials, equipments and services covered under other chapters of tender documents and is not exclusive.

2.0 GENERAL REQUIREMENT

2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Purchaser.

2.3 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification and bid price schedule but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of Nepal/.relevant IEC standard or Acceptable International Standard.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-A of this chapter, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IEC or equivalent international standard.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-A / individual chapters for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out in the Additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-A/

individual chapters for various equipments shall be subject to Purchaser's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipments shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.

4.5 The equipment shall also comply to the following:

a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

b) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 Equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.6.1 System Parameter

220kV System

SL No	Description of parameters	220 kV System
1.	System operating voltage	220kV
2.	Maximum operating voltage of the system(rms)	245kV
3.	Rated frequency	50Hz
4.	No. of phase	3
5.		
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	-
iii)	One minute power frequency dry withstand voltage (rms)	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	460kV
6.	Corona extinction voltage	156kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 156kV rms for 220kV system	1000 micro-volt
8.	Minimum creepage distance (25mm/kV)	6125 mm
9.		
i.	Phase to phase	2100 mm

SL No	Description of parameters	220 kV System
ii.	Phase to earth	2100 mm
iii)	Sectional clearances	5000 mm
10.	Rated short circuit current for 1 sec. duration	40kA
11.	System neutral earthing	Effectively earthed

132kV & 11kVSystem

SL No	Description of parameters	132 kV System	66 kV System	11 kV System
1.	System operating voltage	132kV	66kV	11kV
2.	Maximum operating voltage of the system(rms	145kV	72kV	12kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	28kV
6.	Corona extinction voltage	105kV	-	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 92KV rms for 132KV system	500 micro-volt	-	-
8.	Minimum creepage distance (25mm/kV)	3625 mm	1800 mm	300 mm
9.	Min. Clearances			
i.	Phase to phase	1300 mm	1300 mm	280 mm
ii.	Phase to earth	1300 mm	13000 mm	140 mm
iii)	Sectional clearances	4000 mm	3500 mm	3000 mm
10.	Rated short circuit current	31.5 kA for 1 Sec	31.5 kA for 1 Sec	25 kA for 3 Sec
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

Note :

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable.
2. The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

4.6.2 Major technical parameters of bushings / hollow column / support insulators are given below:

220kV System

S.N.	Parameters	**220 kV**
(a)	Max. System voltage Um(kV)	245
(b)	Impulse withstand voltage (dry & wet) (kVp)	± 1050
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	460
(d)	Total creepage distance (min) (mm)	6125

The requirement of alternate long & short sheds stated in model technical specification shall not be applicable in case of 11 kV.

132kV, 22kV & 11kV System

S.N.	Parameters	**132 kV**	**66kV**	**11kV**
(a)	Max. System voltage Um(kV)	145	72	12
(b)	Impulse withstand voltage (dry & wet) (kVp)	± 650	± 325	± 74
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	275	140	28
(d)	Total creepage distance (min) (mm)	3625	1800	300

4.6.3 Major Technical Parameters

The major technical parameters of the equipments are given below. For other parameters and features respective technical chapters should be referred.

4.6.3.1

(A) For 245 kV & 145 kV Equipments

Rated voltage kV (rms)	245	145
Rated frequency (Hz)	50	50
No. of Poles	3	3
Design ambient temperature (°C)	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

-	between line terminals and ground	± 1050 kVp	±650 kVp
-	between terminals with circuit breaker open	± 1050 kVp	±650 kVp
-	between terminals with isolator open	± 1200 kVp	±750 kVp

2)	One minute power frequency dry and wet withstand voltage		
-	between line terminals and ground	460 kV (rms)	275 kV (rms)
-	between terminals with circuit breaker open	460 kV (rms)	275 kV (rms)
-	between terminals with Isolator open	530 kV (rms)	315kV (rms)
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipments.		1000 (at 156 kV rms)	500 (at 92 kV rms)
Minimum creepage distance :-			
Phase to ground (mm)		6125	3625
Between CB Terminals (mm)		6125	3625
System neutral earthing		Effectively earthed	Effectively earthed
Seismic acceleration		- 0.5g horizontal -	
Rating of Auxiliary Contacts		10 A at 220/110 V DC (as applicable)	
Breaking capacity of Auxiliary Contacts		2 A DC with circuit time constant of not less than 20ms.	
Phase to phase spacing (mm)		4500 or 4000	3000 or 2700

Auxiliary Switch shall also comply with other clauses of this chapter.

(B) FOR 245 kV & 145 kV CT/CVT/SA

Rated voltage kV (rms)		245	145
Rated frequency (Hz)		50	50
No. of poles		1	1
Design ambient temperature (°C)		50	50
Rated insulation levels :			
1)	Full wave impulse withstand voltage (1.2/50 micro sec.)		
-	between line terminals and ground for CT and CVT	± 1050 kVp	±650 kVp
-	for arrester housing	± 1050 kV peak	±650 kVp
2)	One minute power frequency dry and wet withstand voltage		
-	between line terminals and ground for CT and CVT	460 kV rms	275 kV rms
-	for arrester housing	460 kV rms	275kV rms
Max. radio interference voltage (microvolts) for		1000 for CT/CVT 500 for SA	500

frequency between 0.5 MHz and 2 MHz in all positions of the equipment.	(at 156 kV rms)	(at 92 kV rms)
Minimum creepage distance :-		
Phase to ground (mm)	6125	3625
System neutral earthing	- Effectively earthed -	
Seismic acceleration	- 0.5g horizontal -	
Partial discharge for :-		
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -	
- for CT/CVT	- Not exceeding 10 pc. –	

(C) **For 33 kV, 22kV & 11kV Vacuum Circuit Breaker and Isolator**:

Rated voltage kV (rms)	36	25	
Rated frequency (Hz)	50	50	
No. of Poles	3	3	
Design ambient temperature (°C)	50	50	
Rated insulation levels :			
1) Full wave impulse withstand voltage (1.2/50 micro sec.)			
- between line terminals and ground	±170 kVp	±150 kVp	±75 kVp
- between terminals with circuit breaker open	±170 kVp	±150 kVp	±75 kVp
- between terminals with isolator open	±170 kVp	±150 kVp	±75 kVp
2) One minute power frequency dry and wet withstand voltage			
- between line terminals and ground	70kV(rms)	50kV(rms)	28kV(rms)
- between terminals with circuit breaker open	70kV(rms)	50kV(rms)	28kV(rms)
- between terminals with Isolator open	70kV(rms)	50kV(rms)	28kV(rms)
Minimum creepage distance:			
Phase to ground (mm)	900	625	300
Between CB Terminals (mm)	900	625	300
System neutral earthing	Effectively earthed		
Seismic acceleration	0.5 g	0.5 g	
Rating of Auxiliary Contacts	10 A at 250 V DC		
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20ms		

Auxiliary Switch shall also comply with other clauses of Chapter-GTR.

(D) FOR 33kV, 22kV & 11kV CT/VT/SA

Rated voltage kV (rms)	36	25	12
Rated frequency (Hz)	50	50	11
No. of poles	1	1	1
Design ambient temperature (°C)	50	50	50
Rated insulation levels :			
1) Full wave impulse withstand voltage (1.2/50 micro sec.)			
- between line terminals and ground	±170 kVp	±150 kVp	±75 kVp
- for arrester housing	±170 kVp	±150 kVp	±75 kVp
2) One minute power frequency dry and wet withstand voltage			
- between line terminals and ground	70kV rms	50kV rms	28kV rms
- for arrester housing	70kV rms	50kV rms	28kV rms
Minimum creepage distance :			
Phase to ground (mm)	900	625	300
Between Terminals (mm)	900	625	300
System neutral earthing	- Effectively earthed -		
Seismic acceleration	0.5 g	0.5 g	
Cantilever strength of bushing	350 kg (minimum)		

(E) Technical Parameters of Bushings/Hollow Column Insulators/support insulators for 33kV, 22kV & 11kV:

(a)	Rated Voltage (kV)	36	25	12
(b)	Impulse withstand voltage (Dry & Wet) (kVp)	±170	±150 kVp	75
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	75	50	28
(d)	Total creepage distance (mm)	900	625	300

(e) Pollution Class-III Heavy (as per IEC 71) and as specified in Section-2 for all class of equipment.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award.

The Contractor shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. Employer/Consultant has standardized few drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ by Purchaser on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of

		receipt of resubmission.
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
	(a) Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
	(b) Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	As per agreed schedule
(vii)	As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre& per substation)	On completion of entire works

NOTE :

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Purchaser.

(5) The Contractor shall furnish to the Purchaser catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.2 Provisions for Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 230V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55

b) Installed indoor in air conditioned area: IP-31

c) Installed in covered area: IP-52

d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.

e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IEC-60947 (Part-I) / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be provided with English inscriptions.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of

various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at Owner's Corporate Centre, Nepal or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the contractor shall generally cover the following:

(a) His organization structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for bidder's key personnel;

(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

(f) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Purcahser.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective chapters.

9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the originally Scheduled date of bid opening. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally Scheduled date of bid opening.

i) Lightning Impulse Test

ii) Switching Impulse Test

iii) Multiple Chopped Impulse Test (For CT)

iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The Contractor shall intimate the Purchaser the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the contractor.

9.3 The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.4 The Contractor shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and Purchaser. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser /inspector, unless witnessing of the tests is virtually waived, will attend such tests within

fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.5 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.6 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.7 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorized representative to accomplish testing.

9.8 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.9 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.10 The Purchaser reserves the right for getting any field tests not specified in respective chapters of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10.0 TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list

of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to Equivalent International Standards.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing. no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IEC.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005/Equivalent International standard “Code of practice for phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective chapters of the equipments. Glossy white colour inside the equipments /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat

of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.

Base Colour Direction of flow Band Colour

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store,

erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only.

Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10 The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under chapter "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
400V	± 10	50 ± 2.5%	3/4 Wire	Solidly Earthed.
230V	± 10	50 ± 2.5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
110V	95V to 120V	DC	-	Isolated 2 wire System
48V	–	DC	–	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 5.9 meter from plinth level for 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to ANSI/NEMA CC1/ Equivalent International standard and shall be made of materials listed below :

For connecting ,ACSR conductors	Aluminum alloy casting conforming to BS:1490/ Equivalent International Standard
For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminum alloy casting conforming to BS:1490/ Equivalent International Standard with 2mm thick bimetallic liner.
For connecting GI	Galvanized mild shield wire
i) Bolts nuts and plain washers	Electrogalvanised for sizes Plain, washers below M12, for thers hot dip galvanised.
ii) Spring washers for item ‘a’ to ‘c’	Electrogalvanised mild steel

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per NEMA CC1/ Equivalent International Standard and shall also be subjected to routine tests as per NEMA CC1/ Equivalent International Standard. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)

iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, BS:4255 / Equivalent International Standard . Ventilating

Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 230V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests alongwith the routine tests as per IEC 60529/ Equivalent International Standard shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IEC 60529/ Equivalent International Standard including application of, 2.0 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

20.0 TERMINAL BLOCKS AND WIRING

20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals,

washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.

20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a)	All circuits except CT/PT circuits	Minimum of two of 2.5 sq mm copper flexible.
b)	All CT/PT circuits	Minimum of 4 nos. of 2.5 sq mm copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round plug as per Nepalese Standard. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 230 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228/ Equivalent International Standard mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155.The support insulators shall be manufactured and tested as per IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the

shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS : 5621/ Equivalent International Standard .

23.0 MOTORS

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IEC 60529/ Equivalent International Standard . For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691/ Equivalent International Standard .

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Chapter.

23.3 Starting Requirements:

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325/ Equivalent International Standard .

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325/ Equivalent International Standard (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729/ Equivalent International Standard. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS

24.1 1.1 KV Grade Power & Control Cables

24.1.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 KV grade PVC insulated control cables as on the date of bid opening. Further the

manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the originally Scheduled date of bid opening.

24.1.2 Applicable for PVC Power Cable

The manufacturer, whose PVC Power Cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1 KV or higher grade PVC insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.1.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.2 LT Switchgear

24.2.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which should be in successful operation as on originally Scheduled date of bid opening.

24.2.2 The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on originally Scheduled date of bid opening.

ANNEXURE - A

LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-60117	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.
IEC-60376	-	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	-	Radio Interference Test on High Voltage Insulators.
IEC-60507	-	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-62271-1	-	Common Specification for High Voltage Switchgear & Controlgear Standards.
IEC-60815	-	Guide for the Selection of Insulators in respect of Polluted Conditions.
IEC-60865 (P1 & P2)	-	Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70	-	National Electrical Code
ANSI-C37.90A	-	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	-	Techniquest for Dielectric Tests
ANSI-C76.1/EEE21	-	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Metres
ANSI-Y32-2/C337.2	-	Drawing Symbols
ANSI-Z55.11	-	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	-	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	-	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	-	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	-	Quality Assurance Program Requirements
CSA-Z299.2-1979h	-	Quality Control Program Requirements
CSA-Z299.3-1979h	-	Quality Verification Program Requirements
CSA-Z299.4-1979h	-	Inspection Program Requirements

TRANSFORMERS AND REACTORS

IEC-60076 (Part 1 to 5)	-	Power Transformers
IEC-60214	-	On-Load Tap-Changers.
IEC-60289	-	Reactors.
IEC- 60354	-	Loading Guide for Oil - Immersed power trans formers
IEC-60076-10	-	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	-	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	-	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	-	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	-	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100	-	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers
IEC-62271-101	-	High-voltage switchgear and controlgear - Part 101: Synthetic testing
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-62271-110	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching
IEC-62271-109	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Inductive Voltage Transformers.
IEC-60044-5	-	Instrument transformers - Part 5: Capacitor voltage transformers
IEC-60358	-	Coupling capacitors and capacitor dividers.
IEC-60044-4	-	Instrument Transformes : Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.

ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors
BUSHING		
IEC-60137	-	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS		
IEC-60099-4	-	Metal oxide surge arrestors without gaps
IEC-60099-5	-	Selection and application recommendation
ANSI-C62.1	-	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	-	Surge Arresters
CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS		
IEC-60068.2.2	-	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529	-	Degree of Protection provided by enclosures.
IEC-60947-4-1	-	Low voltage switchgear and control gear.
IEC-61095	-	Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2)	-	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	-	Switchgear Assemblies, including metal enclosed bus.
ANSI-C37.50	-	Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39	-	Electric Measuring instrument
ANSI-C83	-	Components for Electric Equipment
NEMA-AB	-	Moulded Case Circuit and Systems
NEMA-CS	-	Industrial Controls and Systems
NEMA-PB-1	-	Panel Boards
NEMA-SG-5	-	Low voltage Power Circuit breakers
NEMA-SG-3	-	Power Switchgear Assemblies
NEMA-SG-6	-	Power switching Equipment
NEMA-5E-3	-	Motor Control Centers
1248 (P1 to P9)	-	Direct acting indicating analogue electrical measuring instruments & their accessories.
Disconnecting switches		
IEC-62271-102	-	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2)	-	High Voltage switches

ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment
PLCC and line traps		
IEC-60353	-	Line traps for A.C. power systems.
IEC-60481	-	Coupling Devices for power line carrier systems.
IEC-60495	-	Single sideboard power line carrier terminals
IEC-60683	-	Planning of (single Side-Band) power line carrier systems.
CIGRE	-	Teleprotection report by Committee 34 & 35.
CIGRE	-	Guide on power line carrier 1979.
CCIR	-	International Radio Consultative Committee
CCITT	-	International Telegraph & Telephone Consultative Committee
EIA	-	Electric Industries Association
Protection and control equipment		
IEC-60051: (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to 23)	-	Electrical relays.
IEC-60297		
(P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60359	-	Expression of the performance of electrical & electronic measuring equipment.
IEC-60387	-	Symbols for Alternating-Current Electricity meters.
IEC-60447	-	Man machine interface (MMI) - Actuating principles.
IEC-60521	-	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	-	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	-	Screw threads
ANSI-B18	-	Bolts and Nuts
ANSI-C37.1	-	Relays, Station Controls etc.
ANSI-C37.2	-	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	-	Requirements for electrical analog indicating instruments

MOTORS

IEC-60034 (P1 to P19:)	-	Rotating electrical machines
IEC-Document 2	-	Three phase induction motors
(Central Office) NEMA-MGI		Motors and Generators

Electronic equipment and components

MIL-21B, MIL-833 & MIL-2750		
IEC-60068 (P1 to P5)	-	Environmental testing
IEC-60326 (P1 to P2)	-	Printed boards
		Material and workmanship standards
ASTM	-	Specification and tests for materials

Clamps & connectors

NEMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors

Bus hardware and insulators

IEC-60120	-	Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137	-	Insulated bushings for alternating voltages above 1000 V.
IEC-60168	-	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	-	Characteristices of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-61462	-	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	-	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units : dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.
IEC-60433	-	Characteristics of string insulator units of the long rod type.
IEC-60471	-	Dimensions of Clevis and tongue couplings of string insulator units.

ANSI-C29	-	Wet process proelain insulators
ANSI-C29.1	-	Test methods for electrical power insulators
ANSI-C92.2	-	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	-	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	-	Iron and steel hardware
CISPR-7B	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	-	Zinc Coating (Hot-Dip) on iron and steel hardware
Strain and rigid bus-conductor		
ASTM-B 230-82	-	Aluminum 1350 H19 Wire for electrical purposes
ASTM-B 231-81	-	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	-	Aluminum - Alloy extruded bar, road, wire, shape
ASTM-B 236-83	-	Aluminum bars for electrical purpose (Bus-bars)
ASTM-B 317-83	-	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)
Batteries and batteries charger		
Battery		
IEC:60896-21&22	-	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	-	Vented type nickel Cadmium Batteries
IEC:60622	-	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	-	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	-	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	-	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	-	Sizing of Ni-Cd Batteries
IEEE-1187	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	-	Guide for selection of VRLA Batteries
Battery Charger		
IEEE-484	-	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
IEEE-485	-	Sizing large lead storage batteries for generating stations and substations

Wires and cables

ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-60096 (part 0 to p4)	-	Radio Frequency cables.
IEC-60183	-	Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228	-	Conductors of insulated cables
IEC-60230	-	Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3)	-	Calculation of the continuous current rating of cables (100% load factor).
IEC-60304	-	Standard colours for insulation for low-frequency cables and wires.
IEC-60331	-	Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-60502	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.

Painting

ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council

HORIZONTAL CENTRIFUGAL PUMPS

API-610	-	Centrifugal pumps for general services
	-	Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps

DIESEL ENGINES

ASME Power Test Code	-	Internal combustion engine PTC-17
	-	Codes of Diesel Engine Manufacturer's Association, USA

PIPING VALVES & SPECIALITIES

BS:5150	-	Specification for cast iron gate valves

PG Test Procedures

NFPA-13	-	Standard for the installation of sprinkler system
NFPA-15	-	Standard for water spray fixed system for the fire protection
NFPA-12A	-	Standard for Halong 1301 Fire Extinguishing System

NFPA-72E	-	Standard on Antomatic Fire Detectors
NFPA-12	-	Standard on Carbon dioxide extinguisher systems
Electrical generating and distributing stations code of practice		
Steel structures		
ANSI-B18.2.1	-	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
ANSI-G8.14	-	Round head bolts
ASTM-A6	-	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	-	Specifications of structural steel
ASTM-A47	-	Specification for malleable iron castings
ASTM-A143	-	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242	-	Specification for high strength low alloy structural steel
ASTM-A283	-	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	-	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	-	Specification for High strength low alloy structural manganese vanadium steel.
ASTM-A572	-	Specification for High strength low alloy colombium-Vanadium steel of structural quality
AWS D1-0	-	Code for welding in building construction welding inspection
AWS D1-1	-	Structural welding code
AISC	-	American institute of steel construction
NEMA-CG1	-	Manufactured graphite electrodes
Piping and pressure vessels		
ASME	-	Boiler and pressure vessel code
ASTM-A120	-	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	-	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	-	Seamless carbon steel pipe for high temperature service
ASTM-A284	-	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction.
ASTM-A234	-	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures

ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	-	Forgings, carbon steel for piping components
ASTM-A307	-	Carbon steel externally threated standard fasteners
ASTM-A193	-	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe flangesand glanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	-	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	-	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	-	Ferrous pipe plug, bushings and locknuts with piplethreads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1	-	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe

ACSR MOOSE CONDUCTOR

IEC:437-1973	Test on High Voltage Insulators NEMA:107-1964 CISPR
Part - V	Overhead Transmission Purposes
BS:215(Part-II)	Aluminium Conductors galvanized IEC:209-1966 steel reinforced extra high
BS:215(Part-II)	voltage (400 kV and above)

GALVANISED STEEL EARTHWIRE

P5:1992)	overhead transmission purposes.

CHAPTER 3.3: SWITCHGEAR
INSTRUMENT TRANSFORMERS
CONTENTS

CHAPTER 3 - SWITCHGEAR

INSTRUMENT TRANSFORMERS

1.0 GENERAL:

1.1 The instrument transformers and accessories shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with the requirements in Chapter 2-GTR.

Current Transformers IEC: 60044-1

Capacitive Voltage Transformers IEC: 60044-5 / IEC-60358

Inductive Voltage Transformers IEC: 60044-2

1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

1.3 The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per **Chapter 2-GTR.**External surface of alumunium can have natural finish.

1.4 The impregnation details alongwith tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

1.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR.

2.0 CONSTRUCTION FEATURES:

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder:

2.1 a) Instrument transformers shall be of 245/145 kV class, oil filled/ SF6 gas filled, suitable for outdoor service and upright mounting on steel structures. 245/145 kV Instrument transformers shall be with shedded porcelain/ polymer bushings/Insulators

b) Bushings/Insulators shall conform to requirements stipulated in Section-GTR. The bushing/insulator for CT shall be one piece without any metallic flange joint.

c) Oil filling and drain plugs, oil sight glass shall be provided for CT and for electromagnetic unit of CVT etc. The Instrument transformer shall have cantilever strength of not less than 350 kg and 350 kg **respectively for** 245kV and 145 kV Instrument transformers. For CVT with polymer housing, the cantilever strength shall not be less than 150kg. Oil filling and drain plugs are not required with SF6 gas filled CT.

d) Instruments transformers shall be hermetically sealed units. Bidder/ Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers *during detailed engineering*.

Bidder/Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.

e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

f) In case of SF_6 filled CTs/Inductive VTs, it shall be provided with a suitable SF_6 gas density monitoring device, with NO/NC contacts to facilitate the remote annunciation and tripping in case of SF_6 leakage. Provisions shall be made for online gas filling. Suitable rupture disc shall be provided to prevent explosion.

2.2 **Terminal box/Marshalling Box:**

Terminal box shall conform to the requirements of Chapter 2-GTR.

2.3 **Insulating Oil:**

a) Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IEC - 60296 (required for first filling). Non–PCB based synthetic insulating oil conforming to IEC 60867 can also be used in the capacitor units of CVT with specific approval from the owner, the proposal for which shall be submitted during detailed engineering stage.

b) The SF6 gas shall comply with IEC-60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under operating conditions.

2.4 **Name Plate:**

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the name plate. The rated thermal current in case of CT shall also be marked on the name plate.

The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 CURRENT TRANSFORMERS:

a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. PF Terminal for measurement of tan delta and capacitance of the unit shall be provided. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case "Bar primary" inverted type current transformers are offered the manufacturer will meet following additional requirements:

(i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

(ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.

(iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.

(iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.

(v) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.

b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.

c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.

d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.

e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.

f) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

g) For 245/145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Chapter 1 – GTS.

h) For 245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

i) The current transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit. The Contractor shall submit the details of packing design to the Purchaser for review.

j) For 245/145 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired upto the terminal blocks.

k) The wiring diagram plate for the interconnections of the three single phase CTs shall be provided inside the marshalling box. A typical wiring diagram No. 0000-000-T-E-L-028 (Sh. 1 & 2) is enclosed herewith to be followed by the Bidder/Manufacturer

l) The current transformers should be suitable for mounting on lattice support structure or pipe structure to be provided by the Contractor in accordance with stipulations of Chapter 2-GTR.

m) The CT shall be so designed as to achieve the minimum risks of explosion in service. Bidder/Manufacturer shall bring out in his offer, the measures taken to achieve this.

n) 245/145 kV current transformers shall be suitable for high speed auto reclosing.

4.0 VOLTAGE TRANSFORMERS:

a) 245/145 kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling..

b) Voltage transformers secondaries shall be protected by HRC cartridge type fuses or MCBs for all the windings. In addition fuses/MCBs shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VTs shall be terminated to the stud type non - disconnecting terminal blocks in the individual phase secondary boxes via the fuse/MCB.

c) CVTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the VT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further, earthing link with fastener to be provided for HF terminal.

d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

e) The damping device, which should be permanently connected to one of the secondary windings, should be capable of suppressing the ferroresonance oscillations.

f) The accuracy of 0.2 on secondary III for all VTs should be maintained through out the entire burden range upto 50 VA on all the windings without any adjustments during operation.

g) 245/145 kV CVTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of Chapter 2-GTR.

h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

i) A protective surge arrester shall be provided *if required,* to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

j) The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time. *A typical wiring diagram no. : 0000-000-T-E-L-029 is enclosed herewith to be followed by the Bidder/Manufacturer.*

5.0 TERMINAL CONNECTORS:

The terminal connectors shall meet the requirements as given in Chapter 2-GTR.

6.0 TESTS:

6.1 In accordance with the requirements in Section-GTR, Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC:60044-1 and IEC: 60044-5/60044-2 respectively.

6.2 The test reports of the type tests and the following additional type tests (additional type tests are required for Instrument Transformers, rated above 72.5 kV only) shall also be submitted for the Purchaser's review.

a) **Current Transformers:**

i) Radio interference voltage test as per IEC 60044-1.

ii) Seismic withstand test.

iii) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit. (not applicable for SF6 filled CT)

iv) Thermal co-efficient test i.e. measurement of tan delta as a function of temperature (at ambient and between 80^{O}C & 90^{O}C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um/□3) (not applicable for SF6 filled CT)

v) The current transformer shall be subjected to Multiple chopped impulse test (not applicable for SF6 filled CT) by any one of the following two methods given below to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. Alternatively, method as per IEC:60044-1 may be followed:

Method I*: 600 negative polarity lightning impulses chopped on crest will be applied to current transformer. The opposite polarity amplitude must be limited to 50% of crest value when the wave is chopped. One impulse per minute shall be applied and every 50 impulse high frequency currents form the windings and total current to earth will be recorded and be compared with reference currents recorded applying one or more (max 20) reduced chopped impulses of 50% of test value.*

Oil samples will be taken before and 3 days after the test. Gas analysis must not show appreciable rate of increase in various gases related with the results of the analysis performed before test.

Total sum of crest values of current through secondaries must not exceed 5% of the crest value of total current to earth.

CT must withstand dielectric tests after this test to pass the test.

Method II*: 100 negative polarity impulses with a rise and fall time of less than 0.25 microsecond corrected to atmospheric condition shall be applied at one minute interval and total current through insulation of earth will be recorded. The amplitude of first opposite polarity should be limited to 50% of the chopped impulse crest value. Voltage and total current wave shapes shall be recorded after every 10 impulses, and will be compared with reference wave shapes recorded before test at 50% of test values.*

Oil sample shall be taken before and 3 days after the test and CT shall be deemed to have passed the test if the increase in gas content before and after test is not appreciable.

b) **Voltage transformers:**

i) High frequency capacitance and equivalent series resistance measurement (as per IEC-60358) for CVT.

ii) Seismic withstand test.

iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-60358) for CVT.

iv) Determination of temperature coefficient test (as per IEC-60358).

v) Radio interference voltage test as per IEC-60044-5/IEC-60044-2. However the RIV level shall be as specified in clause Major Technical Parameters in Section-GTR.

vi) Apart from the above, report of all special tests mentioned in IEC-60044-5 for Capacitive voltage transformer shall also be submitted for approval.

6.3 The current and voltage transformer shall be subjected to the following routine tests in addition to routine tests as per IEC.

a) **CURRENT TRANSFORMERS:**

ROUTINE TESTS:

<u>for Oil filled CTs</u>

i) Measurement of Capacitance.

ii) Oil leakage test.

iii) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/□3.

<u>for SF6 filled CTs</u>

i) Dew point measurement

ii) SF6 alarm/ lockout check.

iii) SF6 leakage test. Gas leakage rate shall be maintained within 0.2% per annum.

b) **VOLTAGE TRANSFORMERS:**

Routine tests on Capacitive voltage transformer shall be done in line with IEC-60044-5.

7.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

The Bidder shall include in his proposal spare parts equipment in accordance with Section-Project.

8.0 TECHNICAL PARAMETERS:

A. 145 kV CURRENT TRANSFORMERS:

B8.1	Rated Primary current	-1400A
B8.2	Rated short time thermal current	31.5 kA for 1 sec.
B8.3	Rated dynamic current	80 kA (peak)
B8.4	Maximum temperature rise over design ambient temperature	As per IEC: 60044-1
B8.5	One minute power frequency withstand voltage sec. terminal & earth	5 kV
B8.6	Number of terminals	All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.
B8.7	Type of insulation	Class A

Current transformers shall also comply with requirements of Table – IIB/ or IIC as applicable.

BB. 72 kV CURRENT TRANSFORMERS:

BB8.1	Rated Primary current	-1250A
BB8.2	Rated short time thermal current	31.5 kA for 1 sec.
BB8.3	Rated dynamic current	80 kA (peak)
BB8.4	Maximum temperature rise over design ambient temperature	As per IEC: 60044-1
BB8.5	One minute power frequency withstand voltage sec. terminal & earth	5 kV
BB8.6	Number of terminals	All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.
BB8.7	Type of insulation	Class A

Current transformers shall also comply with requirements of Table – IIB/ or IIC as applicable.

9.0 PRE-COMMISSIONING TESTS

9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along-with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

9.2 **Current Transformers**

(a) Insulation Resistance Test for primary and secondary.

(b) Polarity test

(c) Ratio identification test - checking of all ratios on all cores by primary injection of current.

(d) Dielectric test of oil (wherever applicable).

(e) Magnetizing characteristics test.

(f) Tan delta and capacitance measurement

(g) Secondary winding resistance measurement

(h) Contact resistance measurement (wherever possible/accessible).

(i) Test for SF6 (for SF6 filled CTs) – Dew point measurement, SF6 alarm/ lockout check.

(j) DGA test of oil.

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Bidder/Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

9.3 **Voltage Transformers/Capacitive Voltage Transformers**

(a) Insulation Resistance test for primary (if applicable) and secondary winding.

(b) Polarity test

(c) Ratio test

(d) Dielectric test of oil (wherever applicable).

(e) Tan delta and capacitance measurement of individual capacitor stacks.

(f) Secondary winding resistance measurement.

TABLE - IA

REQUIREMENTS FOR 145 KV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class as per IEC: 44-1	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	2000-1400/1	-	-	2000/ 1400	AR	AR
	2	BUS DIFF MAIN	2000-1400/1	-	-	2000/ 1400	AR	AR
	3	METERING	2000-1400/1	20	**0.2S**	-	-	-
	4	TRANS. BACK PROTN.	2000-1400/1	-	-	2000/ 1400	AR	AR
	5	TRANS. DIFF/LINE	2000-1400/1	-	-	2000/ 1400	AR	AR

AR: As required. The contractor shall detail design.

All relaying CTs shall be of accuracy class T PS as per IEC 60044-1.

TABLE - IIC

REQUIREMENTS FOR 72 KV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class as per IEC: 44-1	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	1600-1200/1	-	-	1600/ 1200	AR	AR
	2	BUS DIFF MAIN	1600-1200/1	-	-	1600/ 1200	AR	AR
	3	METERING	1600-1200/1	20	**0.2S**	-	-	-
	4	TRANS. BACK	1600-1200/1	-	-	1600/ 1200	AR	AR
	5	TRANS. DIFF/LINE	1600-1200/1	-	-	1600/ 1200	AR	AR

AR: As required. The contractor shall detail design.

All relaying CTs shall be of accuracy class T PS as per IEC 60044-1.

NOTE: The CT Ratio and Rating, for both AIS and GIS shall be finalized during DDE.

Chapter-4

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

1.0 Description of High Temperature Low Sag Conductor and its Technical Requirements

1.1 The HTLS Conductor shall be capable of providing the Ampacity of 1100 A for ACSR Bear equivalent HTLS conductor and 12500 A for Duck Equivalent HTLS conductor, not exceeding the maximum permissible operating temperature for continuous operation of the offered HTLS Conductor and without exceeding the level of maximum permissible sag indicated at normal condition.

The physical and operating performance requirements of the transmission line with HTLS conductor are mentioned below. The bidder shall offer HTLS conductor complying with the specified requirements. The Bidder shall indicate particulars of the proposed conductor in the relevant GTP schedule of BPS along with calculations to establish compliance with the specified requirements.

1.2 Current Carrying Capacity /Ampacity Requirements

1.2.1 Each conductor shall be suitable to carry minimum required Amperes of 50 Hz alternating current under the ambient conditions & maximum conductor sag specified below while satisfying other specified technical requirements/ parameters: -

Elevation above sea level = 0 m

Ambient température : 45 deg C

Solar Absorption coefficient =0.8

Solar Radiation = 1045 watt/sq.m

Emissivity Constant= 0.45

Wind velocity considering angle between wind & axis of conductor as 90 degrees = 0.56m/sec

Effective angle of incidence of sun's rays= 90 deg

Maximum permissible Conductor sag for 447m and 300m span respectively at steady state conductor temperature and nil wind corresponding to 50 Hz alternating current of 1100 Amperes and 780 Amperes per conductor respectively under ambient conditions specified above = Not exceeding the sag for existing ACSR type of Conductor or existing sag of line, whichever is lower.

Pathlaiya – Dhalkebar - Duhabi line: Ruling span: 447m, Max span: 812m, Minimum span; 200m

Inside Kathmandu Valley: Value to be provided later

Above is the approximate data, Successful bidder shall conduct detail survey for above parameter and design and calculate the sag or any necessary design parameter during detail engineering process.

The calculations for Ampacity shall be based on IEEE Standard 738-2006 in SI units. Ratio of AC resistance & DC resistance for HTLS conductor shall be calculated on the basis of the formulae indicated as follows:-

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

$mr = 0.3544938/(R_{dc})^{½}$

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

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

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

$p = 0.7 + 0.11Xmr – 0.04Xmr^2+ 0.0094Xmr^3$

k_2=0.15 for single Aluminium layer INVAR type HTLS conductor

= 0.03 for three Aluminium layer INVAR type HTLS conductor

= 0.003 for two or four Aluminium layer INVAR type HTLS conductor

= 0 for composite core type HTLS conductor

where,

D= conductor outer diameter in metres

d = conductor inner diameter in metres

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

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

The bidder in his bid shall furnish calculations for the ampacity based on the above for the proposed HTLS conductor.

1.2.2 The design of conductor shall be suitable for operation at a steady state conductor temperature experienced for a sub conductor AC current flow of 1100 and 1250 Amperes respectively under the above ambient conditions based on ampacity calculations mentioned above. The bidder shall also indicate the maximum permissible conductor temperature for continuous operation without any deterioration of its electrical, mechanical & metallurgical properties.

The bidder shall also furnish the maximum permissible conductor temperature for short term operations including permissible duration of such short term operation. The UTS of conductor at ambient temperature and maximum continuous operating temperature shall be declared in the GTP. Further, UTS of conductor achieved at

maximum continuous operating temperature shall not be less than 80% of UTS at ambient temperature declared in the GTP.

In case of INVAR conductor & metal-matrix composite core conductor, the maximum permissible conductor temperature for continuous operation shall not be considered more than 210 deg C and in case of carbon fibre composite core conductor, the same shall not be considered more than 180 deg C.

1.3 Technical Particulars of HTLS Conductor

The HTLS conductor shall meet the following minimum requirements:

A. For ACSR Bear Equivalent

B. Description	Criteria
Overall diameter of complete HTLS conductor	Maximum 25 mm, Not less than 21mm
Max allowable sag for 1100A or maximum continuous safe operational temperature for 447 m ruling span	10m or less than the existing sag
Approx. mass of complete conductor (kg/km)	less than or equal 1213 kg/km
Minimum Ultimate Tensile strength of conductor	100 KN
Minimum Ampacity @ Maximum continuous operational temperature	1100 Ampere
For Carbon Fibre Composite Core only:	
Overall diameter of Core of HTLS	More than or equal to 7.75 mm

C. For ACSR Duck Equivalent

Description	Criteria24.2
Overall diameter of complete HTLS conductor	Maximum 25.4 mm, Not less than 23.6 mm
Max allowable sag for 1250 A or maximum continuous safe operational temperature for 300 m span	7.3m or less than the existing sag
Approx. mass of complete conductor (kg/km)	less than or equal 1161 kg/km
Minimum Ultimate Tensile strength of conductor	100 KN
Minimum Ampacity @ Maximum continuous operational temperature	1250 Ampere

For Carbon Fibre Composite Core only:	
Overall diameter of Core of HTLS	More than or equal to 7.75 mm

The bidder shall indicate the technical particulars and details of the construction of the conductor in the relevant schedule of GTP. The bidder shall also guarantee the DC resistance of conductor at 20 deg C and AC resistance at the calculated temperature corresponding to 50Hz alternating current flow of 1100 and 1250 Amperes respectively at specified ambient conditions (designed maximum temperature).

The bidder shall submit the supporting calculations for the AC resistance at 1100 (1250) Amperes and at 550 (650) Amperes for ACSR Bear (Duck) equivalent conductor indicating details & justifications of values of temperature coefficient of resistance & DC to AC resistance conversion factor(s) with due reference to construction / geometry of the conductor.

1.4 Sag-Tension Requirements

1.4.1 The HTLS conductor shall meet the following sag tension requirements for ruling span of 447 meters and 300 m respectively:

Particulars	Limiting value
Tension at every day condition (32°C, no wind)	Not exceeding 25% of UTS of proposed conductor
Sag at designed maximum temperature (corresponding to max. specified temperature Amperes and ambient conditions specified at 1.2.1)	Lower of value of Standard sag for existing ACSR conductor for specified span @ 75DegC and measured sag of existing line @ specified span.
Tension at following wind pressure:-	
i) Tension at 32 deg C, full wind (166.8kg/m^2)	< Tension of existing conductor ≤ not exceeding 70% of UTS of proposed conductor

During Sag Tension Analysis followings points shall be strictly followed.
i. Each conductor must not violate existing sag and existing tension on tower at any operating temperature condition of individual conductors.
ii. While doing so, the factor of safety for individual conductors must be well maintained under all operating condition.

Sag-Tension calculations at various conditions mentioned above shall be submitted along with the bid. These calculations shall also include calculations for determination of transition / knee point temperature.
The bidder shall also furnish sag & tensions under no wind for various temperatures starting from 0 deg C to maximum continuous operating temperature in steps of 5 degC.

The calculations for Sag & tension shall be as described below: -

a) **In case of INVAR Conductor**: Sag-Tension calculations for INVAR conductor can be carried out using conventional methodology or by using PLSCAD.

I) Conventional Method: This methodology is illustrated at Annexure-B to the section. Following values shall be considered for the purpose of sag-tension calculation: -

i) Modulus of Elasticity of Thermal resistant Al alloy strands: 55 GPa to 61.8 GPa

ii) Modulus of Elasticity of INVAR core strands: 155 GPa

iii) Coefficient of Linear Expansion of Thermal resistant Al. Alloy: 23 X 10^{-6} /deg C

iv) Coefficient of Linear Expansion of INVAR core strands (max.): 3.7 X 10^{-6} /deg C

v) Initial temperature in manufacturing conductor- not less than 15 deg C

In case the bidder proposes the coefficient of linear expansion of INVAR core strands less than 3.7 X 10^{-6} /deg C, the bidder shall submit proper justification in the form of test reports, documents, etc. along with the bid.

II) PLS CAD Method: Following values shall be considered for the purpose of sag-tension calculation:-

i) Final values of modulus of elasticity of Aluminium Alloy/ Core strands, Coefficient of Linear Expansion of Aluminium Alloy/ Core strands, Stress-Strain coefficients & Creep coefficients of Aluminium alloy / core strands in the cable data (*.wir* file) used for calculation of sag in PLSCAD shall be based on either of the following :-

a) Existing standard files on PLS website
b) A file derived from existing standard file on PLS website for conductor of equivalent/near equivalent stranding and size.

However, value of Final values of modulus of elasticity of Aluminium Alloy/ Core strands, Coefficient of Linear Expansion of Aluminium Alloy/ Core strands shall be within the limits defined under I) above

In each of the above cases, proper justification in the form of test reports/ calculations/ print out of '.wir' file as available on PLS website, etc. shall be required to be submitted by the bidder along with the bid.

ii) PLSCAD Sagging criteria/conditions shall be based on the sag tension limits specified above at Clause 1.4.1 and shall be carried out in a manner that the above mentioned sag-tension limits are met in "After Creep" as well as in "After Load" condition.

The newly designed conductor without standard published .wir file will not be accepted. For Proposed Design of HTLS Conductor wir file must be available on Power Line Systems website to do sag tension working using PLS CADD software.

b) **In case of composite core conductor**: Sag-Tension calculations for composite core conductor can be carried by using PLSCAD. Following values shall be considered for the purpose of sag-tension calculation: -

i) Final values of modulus of elasticity of Aluminium/ composite core, Coefficient of Linear Expansion of Aluminium/ composite core, Stress-Strain coefficients & Creep coefficients of Aluminium/ composite core in the cable data (.wir file) used for calculation of sag in PLSCAD shall be based on either of the following

a) Existing standard files on PLS website
b) A file derived from existing standard file on PLS website for conductor of equivalent/ near equivalent stranding and size.

In each of the above cases, proper justification in the form of test reports/ calculations/ print out of '.wir' file as available on PLS website, etc. shall be required to be submitted by the bidder along with the bid.

ii) PLSCAD Sagging criteria/conditions shall be based on the sag tension limits specified above at Clause 1.4.1and shall be carried out in a manner that the above mentioned sag-tension limits are met in "After Creep" as well as in "After Load" condition.

The newly designed conductor without standard published .wir file will not be accepted. For Proposed Design of HTLS Conductor wir file must be available on Power Line Systems website to do sag tension working using PLS CADD software.

1.4.2 Various conductor parameters (viz. modulus of elasticity, coefficient of linear expansion, stress-strain and creep, etc.) considered above in the sag tension calculation shall be verified during detailed engineering based on type tests conducted.

1.4.3 The bidder shall also furnish sag & tensions under no wind for various temperatures starting from 0 deg C to designed maximum temperature in steps of 5 degC. The Contractor shall furnish the comparison chart showing sag for both existing ACSR and Proposed Conductor.

1.4.4 After award of the contract, the Supplier shall submit Sag-Tension calculations corresponding to specified conditions and for the ruling span and also all the spans as per detailed survey and spans ranging from 50 m to 300 m in intervals of 50 m.

1.4.5 Besides above, the Supplier shall also furnish during detailed engineering details of creep characteristics in respect of the offered type of HTLS conductor based on laboratory investigations/ experimentation (creep test as per IEE1138 or IEC 61395) conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension &designed maximum temperature as well as at room temperature.

1.4.6 The installation & stringing of the offered HTLS conductor shall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier.

The supplier shall supervise the stringing at site as per the approved stringing procedure. The supplier shall prepare stringing charts for the HTLS conductor showing the initial and final sags and tension for various temperatures and spans along with equivalent spans on the basis of tower schedule prepared by transmission line contractor and submit the same for the approval of the Employer. Site visit for supervision shall be carried out as per instructions of the Employer. The supervision/Inspection work in supplier's scope shall mainly include inspection as per stringing procedure, proper location of drum site, installation of stringing blocks/pulley, proper sagging, proper installation of its fittings & accessories, proper tension as per sag-Tension chart etc. The supervision shall also include arranging all necessary special tools & tackles required for stringing of the offered HTLS conductor free of cost.

1.4.7 The above stringing work including installation of its fittings & accessories shall be supervised by a team of supplier's engineers / supervisory staff/ workmen already experienced in stringing work associated with the type of HTLS conductor being supplied. The bidder shall furnish experience details of the engineers /supervisory staff proposed to be deployed.

1.4.8 The cost of conductor shall also include supply of one set of all the special tools & tackles required for stringing of the offered HTLS conductor.

1.5 Workmanship

1.5.1 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.

1.5.2 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.

1.6 Joints in Wires

1.6.1 Aluminium/ Aluminium Alloy Wires

1.6.1.1 During stranding, no Aluminium Alloy wire welds shall be made for the purpose of achieving the required conductor length.

1.6.1.2 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(s) 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/Alloywires. 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/Alloywire of the completed conductor. A record of such joints for each individual length of the conductor shall be maintained by The Contractor for Employer's review.

1.6.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

1.6.2 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 complete stranded core

1.7 Tolerances

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

For composite cores, the manufacturing tolerance shall be +/- 0.05 mm of the stated nominal value.

1.8 Materials

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

1.8.1 Outer layer

The material of outer layer of HTLS conductor shall be of high temperature resistant aluminum alloy added with zirconium or any other suitable element(s) etc. to electrolytic Aluminium or annealed Aluminium (0 tempered) having purity not less than 99.5%and a copper content not exceeding 0.04%.The strands shall be manufactured through appropriate manufacturing process to ensure consistent electrical, mechanical and metallurgical properties under continuous high temperature operation. Bidder shall guarantee the chemical composition in the schedule GTP of BPS and also furnish description of the manufacturing process in the Bid.

In case of fully annealed type (0 tempered), Aluminium strands trapezoidal/ Z-shaped wires shall only be accepted.

1.8.2 **Core**

The core wire strand(s) shall be of Zinc-5% Aluminium – Mischmetal alloy coated invarwires / galvanized invar wires/ 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 strand(s) in the schedule GTP.

In case, the designed maximum temperature of the offered HTLS conductor exceeds 180 deg C, ordinary zinc coating/ galvanizing of the Steel/Invar core wires shall not be accepted and only aluminium clad or Misch metal coated wires shall be permitted. Bidder shall furnish properties and composition of the core wire strand(s) in the GTP.

Where composite material for core is offered, the material shall be either of High strength grade or extra high strength grade as per ASTM B987.

The zinc used for galvanizing of core (if used) 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 conform to the requirements of relevant standard. Zinc-5% Aluminium –Mischmetal alloy coating, if used, shall conform to and satisfy all the requirements of ASTM B 803 / B 958.

The Aluminium cladding of invar wires shall be with aluminum having purity not less than 99.5 % and shall be thoroughly bonded to the core wire strand(s). The minimum thickness of Aluminium cladding shall be 0.07mm to achieve a minimum conductivity of 14% of IACS. The aluminum matrix core strands shall conform to minimum conductivity of 24% 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 a transmission line in tropical environment conditions these lines will be exposed to as detailed in Section-I. 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 along with the bid.

1.9 Standard Length

1.9.1 The standard length of the conductor shall be indicated by the bidder in the guaranteed technical particulars of offer. A tolerance of +/-5% on the standard length offered by the Bidder shall be permitted. Standard Length shall not be more than 2500 m. All lengths outside this limit of tolerance shall be treated as random lengths.

1.9.2 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.

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

1.10 Evaluation of Ohmic Losses & Differential Price Loading

1.10.1 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:

Average Ohmic loss (kW) = Total Running Conductor length X (Continuous operating current under normal condition)^2 XAC Resistance corresponding to continuous operating current

For proposed length in km conductor length, continuous operating current of 550 Amp for ACSR Bear equivalent and 650A for ACSR Duck equivalent conductor;

Average Ohmic loss (kW) = Total Length x (550)^2 x Rac/1000

Where Rac is the AC resistance per km guaranteed by the bidder at temperature corresponding to the continuous operating current under normal condition.

Differential price evaluation for the conductors offered by the bidders shall be carried out considering the average ohmic losses calculated as above and considering US $ 2962 per kW.

The best parameter of loss (lowest ohmic loss for conductor)corresponding to lowest AC resistance quoted among bidders by any technically responsive and 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.

2.0 Tests and Standards

Design validation test for Carbon Fiber Composite Core

In case of composite core type conductors, composite Core manufacturer must have successfully performed design validation tests prior to bid submission as per ASTM B987 on the class of core being offered and it must be witnessed by the representative (s) of Utility or witnessed by representative of a Laboratory which is accredited to ISO/IEC 17025 (different than that of laboratory where tests were performed).

2.1 Type Tests

2.1.1 Type Tests on Stranded Conductor/ Stranded wire

The following tests shall be conducted as per ASTM but not limited to them, once on sample/samples of conductor from each manufacturing facility:

(i)	**On complete Conductor**	
a)	DC resistance test on stranded conductor	: As per Annexure-A
b)	UTS test on stranded conductor	: As per Annexure-A
c)	Radio interference voltage test (dry)	: As per Annexure-A
d)	Corona extinction voltage test (dry)	: As per Annexure-A
e)	Stress- Strain test on stranded conductor and core at room temperature	: IEC 61089
f)	Stress-strain test on stranded conductor and core at elevated temperature	As per Annexure-A
g)	High temperature endurance & creep test on stranded conductor	: As per Annexure-A
h)	Sheaves Test	: As per Annexure-A
i)	Axial Impact Test	: As per Annexure-A
j)	Radial Crush Test	: As per Annexure-A
k)	Torsional Ductility Test	: As per Annexure-A
l)	Aeolian Vibration Test	: As per Annexure-A
m)	Temperature Cycle Test	: As per Annexure-A
(ii)	**On Conductor Strand/core**	
a)	Heat resistance test on Aluminium Alloy strands or core	: As per Annexure-A
b)	Bending test on core (if applicable)	: As per Annexure-A
c)	Compression test on core (if applicable)	: As per Annexure-A
d)	Coefficient of linear expansion on core wire	: As per Annexure-A
e)	Strand Brittle fracture test (for Carbon fibre composite core only)	: As per Annexure-A

2.1.2 Type tests specified under Clause 2.1.1 shall not be required to be carried out if a valid test certificate is available for the offered design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the

country where laboratory is located) or witnessed by the representative (s) of POWERGRID or Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to noncompliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor as per the quoted as per BPS schedule 4(d).

2.2 Acceptance Tests

a)	Visual and dimensional check on drum	: As per Annexure-A
b)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annexure-A
c)	Dimensional check on core or core strands and Aluminium or Aluminium Alloy strands	: As per Annexure-A
d)	Check for lay-ratios of various layers	: As per Annexure-A
e)	Galvanising test on core strands(if applicable)	: As per Annexure-A
f)	Thickness of aluminum on Aluminium clad wires	: As per Annexure-A
g)	Torsion and Elongation tests on core strands	: As per Annexure-A
h)	Breaking load test on core strands and Aluminium / Aluminium Alloy strands	: As per Annexure-A
i)	Wrap test on core strands and Aluminium Alloy strands (not applicable for carbon fibre composite core)	: As per IEC:888 & IES:889
j)	Resistivity test or Minimum conductivity test on Aluminium/ thermal resistant Aluminium Alloy strands	: As per IEC : 889
k)	Procedure qualification test on welded joint of Aluminium / Aluminium Alloy strands	: As per Annexure-A
l)	Heat resistance test on Aluminium Alloy strands	: As per Annexure-A
m)	Ageing test on filler (if applicable)	: As per Annexure-A
n)	Minimum conductivity test on Aluminium clad core wires (if applicable)	: As per Annexure-A
o)	Glass transition temperature test (For Carbon fibre-composite core only)	: As per Annexure-A
p)	Flexural Strength test(For Carbon Fibre-composite core only)	: As per Annexure-A

q)	Coating Test on Zinc – 5% Al -Mischmetal alloy : Coating (if applicable)	: As per ASTM B803/B958
r)	Adherence of Coating Test on Zinc – 5% : Al - Mischmetal alloy Coating (if applicable)	: As per ASTM B803/B958
t)	Bending test on polymer composite core	
t)	Galvanic Protection Barrier Layer Thickness test (on polymer composite core)	As per ASTM B958

Note: All the above tests except (m) shall be carried out on Aluminium Alloy and core / core strands after stranding only.

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 tests as mentioned above to be carried out on 10 % of drums

2.4 Tests during Manufacture

a)	Chemical analysis of zinc used for galvanizing	: As per Annexure-A
b)	Chemical analysis of Aluminium alloy used for making Aluminium Alloystrands	: As per Annexure-A
c)	Chemical analysis of core strands/composite core (not on polymer composite core)	: As per Annexure-A

2.5 Testing Expenses

2.5.1 As indicated in Clause 2.1.2, no type test charges shall be payable to the supplier.

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 test successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

2.5.3 Bidder shall indicate the laboratories in which they propose to conduct the type tests, if required. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.

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

2.5.5 In case of failure in any type test, 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 Supplier's notice of testing, the Employer's representative does not find material/ testing facilities to be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

2.5.6 The Supplier shall intimate the Employer about carrying out of the type tests alongwith 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.

2.6 Additional Tests

2.6.1 The Employer 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 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 Supplier’s premises or at any other test centre. 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 Employer.

2.7 Sample Batch for Type Testing

2.7.1 The Supplier shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Employer’s Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Employer.

2.7.2 The Supplier shall offer at least three drums for selection of sample required for conducting all the type test.

2.7.3 The Supplier is required to carry out all the acceptance tests successfully in presence of Employer’s representative before sample selection.

2.8 Test Reports

2.8.1 Copies of type test reports shall be furnished in at least three copies along with one original. One copy will be returned duly certified by the Employer only after which the commercial production of the material shall start.

2.8.2 Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Employer's representative.

2.8.3 Test Certificates of tests during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Employer.

2.9 Inspection

2.9.1 The Employer'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 Employer 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 Employer 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 relieve the Supplier of any of his responsibilities for meeting all requirements of the Specification, and shall not prevent subsequent rejection it such material is later found to be defective.

2.10 Test Facilities

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

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

b) Standard resistance for calibration of resistance bridges.

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

2.11 Packing

2.11.1 The conductor shall be supplied in non-returnable, strong, wooden/painted steel/hybrid (painted steel cum wood) drums provided with lagging 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. As an alternative to wooden drum Bidder may also supply the conductors in returnable painted steel drums or returnable wood-Steel hybrid

drums. The Supplier shall select suitable drums for supply of conductor and shall be responsible for any loss or damage to conductor and/or drum during transportation handling and storage due to improper selection of drum or packing. Wooden/Steel drum/Wood-Steel hybrid drum will be treated at par for evaluation purpose and accordingly the Bidder should quote in the package.

2.11.2 After completion of stringing works, the supplier shall take back or dispose off the empty drums on his own, except for the drums of spare conductor, if any, which shall be kept by the Owner.

2.11.3 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.

2.11.4 The Bidder should submit their proposed drum drawings along with the bid.

2.11.5 One conductor lengthonly shall be wound on each drum.

2.11.6 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.

2.11.7 Marking

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

(a) Contract/Award letter number.

(b) Name and address of consignee.

(c) Manufacturer’s name and address.

(d) Drum number

(e) Size of conductor

(f) Length of conductor in meters

(g) Arrow marking for unwinding

(h) Position of the conductor ends

(i) Distance between outer-most Layer of conductor and the inner surface of lagging.

(k) Barrel diameter at three locations & an arrow marking at the location of the measurement.

(l) Number of turns in the outer most layer.

(m) Gross weight of drum after putting lagging.

(n) Tear weight of the drum without lagging.

(o) Net weight of the conductor in the drum.

(p) CIP/MICC No.

The above should be indicated in the packing list also.

2.12 Verification of Conductor Length

The Employer reserves the right to verify the length of conductor after unreeling at least ten (10) percent of the drums in a lot offered for inspection.

2.13 Standards

2.13.1 The conductor 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.

2.13.2 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.

Sr. No	Title	International Standard
1	Specification for zinc	BS:3436-1986
2	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970, ASTM B987
3	Aluminum Conductor Galvanised Steel Reinforced	BS;215-1970 IEC:1089-1991, ASTM B987
4	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970, ASTM B987
5	Reels and Drums for Bare Conductors	BS:1559-1949, ASTM B987
6	Method of Tensile Testing of Steel Wire	ISO 6892-1984, ASTM B987
7	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
8	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9	Galvanised Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969, ASTM B987

10	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 1973, ASTM B987
11	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
12	Aluminium Alloy Redraw Rods	IEC 104 1987, ASTM B987
13	Zinc Coated steel wires for stranded Conductors	IEC : 888-1987, ASTM B987
14	Hard drawn Aluminium wire for overhead line conductors	IEC : 889-1987, ASTM B987
15	Aluminium Alloy stranded conductor	IEC : 208-1966 BS-3242-1970, ASTM B987
16	Aluminium clad steel wires	IEC:1232
17	Method of measurement of resistivity of metallic materials	IEC:468,, ASTM B987
18	Ampacity	IEEE738, ASTM B987
19	Thermal resistant Aluminium Alloy	IEC 62004
20	Carbon Fiber Thermoset Polymer Matrix Composite Core (CFC) for use in Overhead Electrical Conductors	ASTM B987

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile 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. ManakBhavan, 9, Bahadur Shah ZafarMarg, 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.
ASTM	ASTM International: 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA

Annexure-A

1.0 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 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate up to 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 minimum 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.

*The test is to be conducted at ambient temperature, between minimum and maximum ambient temperature of 0 deg C and 50 deg C respectively.

b) UTS Test on Stranded Conductor at elevated temperature UTS Test on Stranded Conductor shall be conducted as per clause no. 1.1(a) specified above keeping conductor temperature at the designed maximum temperature.

1.2 Corona Extinction Voltage Test [for 400kV System]

Two samples of conductor of minimum 5 m length each shall be strung in horizontal twin bundle configuration with spacing of 450 mm between subconductors at a height not exceeding 8.84m above ground. The twin bundle assembly when subjected to 50 hz 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 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 voltage should be corrected for standard atmospheric conditions.

1.3 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage level below 1000 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry conditions. This test may be carried out with corona control rings and arcing horns.

1.4 D.C. 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 using micro ohm meter of suitable 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 20deg C as per IS:398-(Part-IV)/(Part-V). The resistance corrected at 20deg C shall conform to the requirements of this Specification.

1.5 Stress-strain test at elevated temperature

Stress-strain test as per IEC-61089 shall be conducted keeping conductor temperature at designed maximum temperature. UTS for this test shall be 80% of the UTS guaranteed in the GTP.

1.6 High Temperature endurance & creep test

Two conductor samples of length equal to at least 100 X d + 2 X a (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor samples shall be subjected to tests as indicated below:

(i) On one of the conductor samples, the conductor temperature shall be maintained at 20 deg 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 hour, 100 hour and subsequently every 100 hour up to 1000 hours time period.

(ii)On other conductor sample, the conductor temperature shall be increased to designed maximum temperature steps of 20 deg. 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 designed maximum temperature +10 Deg. 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 hour, 100 hour and subsequently every 100 hour upto 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. 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 and the same shall not be degraded by more than 10 % over the initial value. The supplier shall plot the thermal elongation with temperature.

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

1.7 Sheaves Test

The conductor sample of minimum length of 35 meter shall be tensioned at 25 % of the UTS and shall be passed through pulleys having diameter of 32 times that of the conductor with angle of 20 deg. between the pulleys. The conductor shall be passed over the pulleys 36 times a speed of 2 m/sec. After this test UTS test on the conductor shall be carried out as mentioned above at clause 1.1. In case of polymer composite core conductors, the core shall be inspected for any sign of damage or cracking through dye penetration test as per ASTM D5117 / ASTM B987 section 14. Dye penetrant exposure time shall be 30 +1/-0 minutes..

1.8 Axial Impact Test

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

1.9 Radial Crush Test

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

1.10 Torsional Ductility Test

The conductor sample of 10-15 m or 1500 times core diameter shall be loaded to 20% of UTS and then rotated in increasing steps of +/-180 deg. In case of INVAR type HTLS conductor, the entire conductor shall withstand atleast 16 such rotation and there shall not be any damage to Aluminium Alloy or core wires.

In case of carbon-fibrecomposite core conductors, after 4 rotations or after separation of Aluminium strands, the Aluminium wires shall be cut and removed from the conductor and the exposed core shall be twisted upto 16 rotations. The composite core shall withstand upto 16 rotations.

1.11 Aeolian Vibration Test

The conductor and supporting hardware shall be loaded to 25% of UTS. A dynamometer, load cell, calibrated beam or other device shall be used to measure the conductor tension. Some means should be provided to maintain constant tension to allow for temperature fluctuations during the testing. The overall span between system terminations shall be a minimum of 30 m. The span shall be supported at a height such that the static sag angle of the cable to horizontal is (1.5 $\pm$ 0.5) deg in the active span. Means shall be provided for measuring and monitoring the mid-loop (antinode) vibration amplitude at a free loop, not a support loop. An electronically controlled shaker shall be used to excite the conductor in the vertical plane. The shaker armature shall be securely fastened to the conductor so it is perpendicular to the conductor in the vertical plane. The shaker should be located in the span to allow for a minimum of six vibration loops between the suspension assembly and the shaker

The test shall be carried out at one or more resonance frequencies (more than 10 Hz) . The amplitude (peak-to-peak) at the antinode point shall be one third of conductor diameter. The assembly shall be vibrated for not less than 10 million cycles without any failure. After the test, the conductor should not exhibit any damage (broken strands). The conductor shall be tested to demonstrate that it retains at least 95% UTS.

1.12 Temperature Cycle Test

The purpose of this test is verification of degradation characteristics of metallic and non-metallic material when subjected to thermal cycling temperature cycling can create large internal stresses due to thermal expansion mismatch between constituents.

Test Methods:-

-Mechanical tension, 20 % UTS, marks on the conductor at the edge of the conductor

-100 cycles from room temperature up to designed maximum temperature. Hold at designed maximum temperature ± 2.5deg. C for 5 minutes

-After the above mentioned 100 cycles, the mechanical tension shall be increased up to 70 % UTS at room temperature and kept at this tension for 24hrs. Thereafter, release to 20 % UTS.

-This cycling test shall be repeated 5 times.

-During the test, temperature of connectors, conductor and resistance are recorded according to ANSI C 119.

-A breaking load test is applied at the end of the test. Conductor strength has to be higher than 95 % UTS.

- In case of polymer composites, the flexural strength should not degrade by more than 10 % and the Glass Transition temperature shall not degrade by more than 10 % after thermal cycling. Flexural strength shall be obtained on the basis of test procedure indicated at 1.32 below. The value of Tg after the test, shall however, in no case be less than the design maximum temperature of conductor.

1.13 Heat Resistance test on Aluminium Alloy wire (not applicable to fully annealed aluminum)

Breaking load test as per clause 1.21 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 the conductor	Test Temperature
Upto 150 deg. C	230 degC (+5/-3 degC)
More than 150 deg. C & upto 210 deg. C	280 degC (+5/-3 degC)
More than 210 deg. C & upto 230 deg. C	400 degC (+5/-3 degC)

1.14 Bending test on Aluminium clad core wire (if applicable)

A sample of Aluminium clad invar strand measuring 30 cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and 90 degree 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.

1.15 Compression test on Aluminium clad wires (if applicable)

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

1.16 Coefficient of linear expansion for core/ core wires

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15 degree C from 15 degree C to designed maximum temperature corresponding to rated current(1200A)by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.17 Strand Brittle fracture test (for carbon-fibre composite core only)

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 for 96 hrs. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm.The rod shall withstand UTS test after 96 hours.

1.18 Visual and Dimensional Check on Drums

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

1.19 Visual Check for Joints, Scratches etc.

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. Ten percent (10%) drums from each lot shall be rewound in the presence of the Employer's representative.

1.20 Dimensional Check on Core/ CoreWires and Aluminium/ Aluminium Alloy Wires

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification. Diameter of formed wires shall be determined as per Clause 6.3.1.2 of IEC 62420.

1.21 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 Contractor.

1.22 Galvanising Test

The test procedure shall be as specified in IEC: 888. 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.

1.23 Aluminum thickness on aluminum clad wires (if applicable)

The thickness of Aluminium of the specimen shall be determined by using suitable electrical indicating instruments operating on the permeameter principle, or direct measurement. Measurements shall be read to three decimal places, and number rounded to two decimal places is considered as measured thickness. For reference purposes, direct measurement shall be used to determine Aluminium thickness on specimens taken from the end of the coils.

1.24 Torsion and Elongation Tests on Composite Core/ INVAR Core wires

The test procedures for Torsion and Elongation Tests on Core wires shall be as per clause No. 6.3.3 and 6.3.2 b) of IEC 61232 respectively. In torsion test, the number of complete twists before fracture shall not be less than the value specified in the GTP on a length equal to 100 times the standard diameter of the strand. 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 at fracture of the strand shall not be less than the value specified in the GTP for a gauge length of 250 mm.

In case of carbon-fibre composite core HTLS conductor, the following procedure shall be applicable:-

i) **Elongation Test**:- The elongation of the composite core sample at fracture shall be determined using extensometer. The load along the core shall be gradually increased. The elongation achieved on reaching the tensile strength of the core shall not be less than the value guaranteed in the GTP.

ii) **Torsion Test** : The purpose of the testis to determine the resilience of the composite core to twisting and to show that after the composite core has experienced the prescribed twisting, it will not crack or have a loss in tensile strength due to the twisting. A sample length that is 170 times the diameter of the composite core being tested is mounted in the gripping fixtures. One grip shall then be fixed so that it does not twist and the other end shall be twisted a full 360 degrees and then fixed in this position for 2 minutes. Once the twist time is completed, the core is untwisted an inspected for any crazing or other damage. If no damage is observed, the composite core is then tensile tested to failure and the final load recorded. For the test to be accepted, the composite core must withstand at least 100% of its rated tensile strength. Two samples need to be completed in order to satisfy the testing requirement.

1.25 Breaking load test on Aluminium/ Aluminium Alloy &Composite core/ INVAR Corewires and D.C Resistance test on Aluminium/ Aluminium Alloy wire

The above tests shall be carried out as per IEC: 888/889 or relevant international standards and the results shall meet the requirements of the specification.

For composite cores, the breaking load shall be performed as described in Section 9 of ASTM B987.

1.26 Wrap test on Corewires (Applicable for steel/Al clad Steel/invar core only)

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

1.27 Minimum conductivity test on thermal resistant Aluminium alloy wire

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

1.28 Procedure Qualification test on welded Aluminium/ Aluminium Alloy wire.

Two Aluminium/ Aluminium Alloywire shall be welded as per the approved qualityplan 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 individual strands.

1.29 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be 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.

1.30 Aluminium conductivity test on Aluminium clad wire (if applicable)

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

1.31 Glass Transition Temperature Test (for carbon-fibre composite core only)

Test shall be conducted as per ASTM B987. The minimum glass transition temperature shall be either (i) the design maximum continuous operating temperature of the offered HTLS conductor + 35 deg C or (ii) minimum glass transition temperature as per ASTM B987 i.e.180 deg. C + 25 deg C ; Whichever is lower.

In case, the design maximum continuous operating temperature of the offered HT/HTLS conductor is more than the minimum glass transition temperature as per

ASTM B987 i.e. more than 180 deg. C then, the test shall be conducted as per ASTM B987 & the minimum glass transition temperature shall be the design maximum continuous operating temperature of the offered HTLS conductor + 25 deg C.

1.32 Flexural Strength Test (for carbon-fibre composite core only)

Test method shall be as per ASTM D7264, ASTM D4475 or ISO 14125. The flexural strength shall not be less than the value guaranteed in the GTP.

1.33 Chemical Analysis of Aluminium/Aluminium Alloy and Composite core/INVAR Core Wires (not applicable for non-metallic composite core)

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

1.34 Chemical Analysis of Zinc

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

1.35 Bending test on polymer composite core (Type test):

Bending test on polymer composite core (CFC) before stranding shall be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from composite core at conductor manufacturing unit before stranding of conductor. Alternatively Bending test on polymer composite core (CFC) before stranding may be performed at the core manufacturing unit on the samples taken from the same reel being supplied to conductor manufacturer subject to proper traceability of the same at the conductor manufacturers works.

Bending test on polymer composite core (CFC) shall also be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from stranded conductor. For test after stranding the diameter of cylindrical mandrel shall be as following:

1) For high strength grade CFC – 60 times the diameter of CFC

2) For Extra high strength grade CFC – 70 times the diameter of CFC

Bending test on polymer composite core (Acceptance test):

Bending test on polymer composite core (CFC) shall be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from stranded conductor. For test after stranding the diameter of cylindrical mandrel shall be as following: 1) For high strength grade CFC – 60 times the diameter of CFC 2) For Extra high strength grade CFC – 70 times the diameter of CFC.

NOTE:

The existing line structure and foundation were constructed and installed more than 20 years ago. So the Contractor shall propose the conductor size and weight a suitable for the safe operation. The conductor stringing shall be carried out at safe tension level such as not to damage the structure.

Annexure-B

Range of temperature t	$t < t_c$	$t = t_c$	$t_c < t \le 230$
Tension equation	$f^2\left[f - \left\{K - \alpha E\left(t - t_{max}\right)\right\}\right] = M$ where $K = f_{max} - \frac{E}{24}\left(\frac{q\delta S}{f_{max}}\right)^2$ $M = \frac{E}{24}(\delta S)^2$ $f = \frac{T}{A}$ $f_{max} = \frac{T_{max}}{A}$ $\delta = \frac{W_c}{A}$ $q = \frac{W_{max}}{W_c} = \frac{\sqrt{(W_c + W_s)^2 + W_w^2}}{W_c}$ t_{max} ; Temperature at T_{max} W_s ; Snow ice weight W_w ; Wind load	$f_c^2\left[f_c - \frac{\alpha_c - \alpha}{\alpha_c}\left\{K - \alpha E\left(t_c - t_{max}\right)\right\}\right] = \frac{\alpha_c - \alpha}{\alpha_c} M$ where $K = f_{max} - \frac{E}{24}\left(\frac{q\delta S}{f_{max}}\right)^2$ $M = \frac{E}{24}(\delta S)^2$ $f_c = \frac{T_c}{A}$ $f_{max} = \frac{T_{max}}{A}$ $\delta = \frac{W_c}{A}$ $q = \frac{W_{max}}{W_c} = \frac{\sqrt{(W_c + W_s)^2 + W_w^2}}{W_c}$ t_{max} ; Temperature at T_{max} W_s ; Snow ice weight W_w ; Wind load After tension equation was solved, t_c is calculated by $t_c = \frac{f_c}{E(\alpha_c - \alpha)} + t_0$	$f^2\left[f - \left\{K - \alpha_{11} E_1\left(t - t_c\right)\right\}\right] = M$ where $K = f_{tc} - \frac{E_1}{24}\left(\frac{\delta_1 S}{f_{tc}}\right)^2$ $M = \frac{E_1}{24}(\delta_1 S)^2$ $f = \frac{T}{A_1}$ $f_{tc} = \frac{T_c}{A_1}$ $\delta_1 = \frac{W_c}{A_1}$
Sag of conductor d	$d = \frac{\delta S^2}{8f}$	$d = \frac{\delta S^2}{8f}$	$d = \frac{\delta S^2}{8f}$

Definition of Symbols are as follows:-

tc	Knee point Temperature
Tc	Tension at Knee point temperature, tc

ΔL	Elongation and thermal expansion of conductor (m)
ΔL_a	Elongation and thermal expansion of aluminum part (m)
ΔL_i	Elongation and thermal expansion of invar core (m)
α	Equivalent coefficient of linear expansion for conductor (1/°C)
α_a	Coefficient of linear expansion for aluminum alloy wire (1/°C)
α_{i1}	Coefficient of linear expansion for aluminum-clad invar wire between room temperature and 230°C (1/°C)
α_{i2}	Coefficient of linear expansion for aluminum-clad invar wire between 230°C and 290°C (/°C)
E	Equivalent modulus of elasticity for conductor (kgf/mm²)
E_a	Modulus of elasticity for aluminum alloy wire (kgf/mm²)
E_i	Modulus of elasticity for aluminum-clad invar wire (kgf/mm²)
A	Nominal cross sectional area of conductor (mm²)
A_i	Nominal cross sectional area of invar core (mm²)
W_c	Nominal weight of conductor (kg/ m)
T	Tension of conductor (kgf)
t_0	Initial temperature in manufacturing conductor (°C)
S	Span length (m)

SAMPLE CALCULATION

Actual calculation of sag and tension for Linnet ZTACIR/AS

(1) Calculation condition

i) Properties of Linnet ZTACIR/AS

D (Diameter of conductor)	18.2 mm
A (Nominal cross sectional area of conductor)	196.5 mm²
A_i (Nominal cross sectional area of invar core	37.16 mm²
W (Nominal weight of conductor)	0.7066kg/m
E (Equivalent modulus of Elasticity for conductor)	8040 kgf/mm² (78.8 GPa)
E_i (Modulus of Elasticity for aluminum-clad invar wire)	15,500 kgf/mm² (152.0 GPa)
α (Equivalent coefficient of linear expansion for conductor)	16.0×10^{-6} 1/℃
α_a (Coefficient of linear expansion for aluminum alloy wire)	23×10^{-6} 1/℃
α_{ia} (Coefficient of linear expansion for aluminum-clad invar wire between transition temp.and 230℃)	13.7×10^{-6} 1/℃

ii) Loading condition under maximum tension

Temperature under maximum tension	15℃
Wind pressure	100kgf/m²
Thickness of snow ice (snow ice weight)	0mm(0kg/m)
Maximum tension	2,300 kgf (22.6 kN)

iii) Span length

S=300m

(2) Calculation of sag and tension at continuous operation temperature

The sag and tension at the continuous operation temperature (205℃) are calculated by the method described in Table

i) Tension at the transition temperature T_c

$$q = \frac{W_{max}}{W_c} = \frac{\sqrt{0.7066^2 + (18.2\times100/1000)^2}}{0.7066}$$

$$= 2.7630$$

$$f_{max} = \frac{T_{max}}{A} = \frac{2300}{196.5}$$

$$= 11.705$$

$$\delta = \frac{W_c}{A} = \frac{0.7066}{19.65}$$
$$= 3.5959 \times 10^{-3}$$
$$K = f_{av} - \frac{E}{24}\left(\frac{g\delta S}{f_{av}}\right)^2 = 11.705 - \frac{8040}{24} \times \left(\frac{2.7630 \times 0.0035959 \times 300}{11.705}\right)^2$$
$$= -10.018$$
$$M = \frac{E}{24}(\delta S)^2 = \frac{8040}{24} \times (0.0035959 \times 300)^2$$
$$= 389.85$$
$$\frac{\alpha_c - \alpha}{\alpha_c} = \frac{23 - 16.0}{23} = 0.30435$$

$\therefore$
$$f_c^2\left[f_c - 0.30435 \times \left\{-10.018 - 16.0 \times 10^{-6} \times 8040 \times (15 - 15)\right\}\right] = 0.30435 \times 389.85$$
$$f_c^2\left[f_c + 3.0490\right] = 118.65$$
$$f_c = 4.0796$$
$$T_c = f_c A = 4.0796 \times 19.65$$
$$= 801.64 \text{ kgf}$$

ii) Transition temperature t_c

$$t_c = \frac{4.0796}{8040 \times (23 - 16.0) \times 10^{-6}} + 15$$
$$= 87.49\,^{\circ}\text{C}$$

iii) Sag d and tension T at the continuous operation temperature (205°C)

$$f_{ic} = \frac{T_{max}}{A_i} = \frac{801.64}{37.16}$$
$$= 21.573$$
$$\delta_i = \frac{W_c}{A_i} = \frac{0.7066}{37.16}$$
$$= 1.9015 \times 10^{-2}$$
$$K = f_{ic} - \frac{E_i}{24}\left(\frac{\delta_i S}{f_{ic}}\right)^2 = 21.573 - \frac{15500}{24} \times \left(\frac{0.019015 \times 300}{21.573}\right)^2$$
$$= -23.585$$
$$M = \frac{E_i}{24}(\delta S)^2 = \frac{15500}{24} \times (0.019015 \times 300)^2$$
$$= 21016$$

$\therefore$
$$f^2\left[f - \left\{-23.585 - 3.7 \times 10^{-6} \times 15500 \times (205 - 87.49)\right\}\right] = 10901$$
$$f^2\left[f + 30.324\right] = 21016$$
$$f = 20.362$$
$$T = fA_i = 20.362 \times 37.16$$
$$= 756.7 \text{ kgf at } 205^{\circ}\text{C } (7.42\text{kN})$$
$$d = \frac{\delta S^2}{8f} = \frac{0.019015 \times 300^2}{8 \times 20.362}$$
$$= 10.51 \text{ m at } 205^{\circ}\text{C}$$

CHAPTER 6: POWER AND CONTROL CABLE

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CHAPTER 6: POWER & CONTROL CABLES

1. POWER & CONTROL CABLES[FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.

1.1.3 For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.

1.1.4 Employer has standardised the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows:

S.No.	From	To	Cable size	Cable type
1.	AC Distribution Board	Bay MB	1-3½C X 70 mm^2	PVC
2.	DCDB	Protection/PLCC panel	1-4C X 16 mm^2	PVC
3.	Bay MB	Equipments	1-4C X 16 mm^2 /1-4C X 6 mm^2 /1-2C X 6 mm^2	PVC

1.1.5 Bidder may offer sizes other than the sizes specified in clause 1.1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for employer's approval.

1.1.6 Cables shall be laid as per relevant IEC/International Standards.

1.1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.1.7.1 Separate cables shall be used for AC & DC.

1.1.7.2 Separate cables shall be used for DC1 & DC2.

1.1.8 For different cores of CT & CVT separate cable shall be used

1.1.9 Atleast one (1) cores shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.1.10 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5 sq.mm. size shall be provided.

1.1.11 Technical data requirement sheets for cable sizes are being enclosed at Annex-I.

1.1. TECHNICAL REQUIREMENTS

1.1.1. General

1.1.1.1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.1.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature (70 deg C for PVC insulated cables and 90 deg C for XLPE insulated cables). The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

1.1.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

1.1.1.4. The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

1.1.1.5. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

1.1.1.6. Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

1.1.1.7. Strip wire armouring method shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

1.1.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

1.1.1.9. All the cables shall pass fire resistance test as per IEC: 60502 (Part-I)

1.1.1.10. The normal current rating of all PVC insulated cables shall be as per IEC: 60502.

1.1.1.11. Repaired cables shall not be accepted.

1.1.1.12. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

1.1.2. **PVC Power Cables**

1.1.2.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IEC: 60502 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IEC: 60502. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IEC: 60502 for all cables.

1.1.3. **PVC Control Cables**

1.1.3.1. The PVC ***(70°C) insulated*** control cables shall be of FR type C1 category conforming to IEC: 60502 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IEC: 60502. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IEC: 60502 and shall be grey in colour .

1.1.3.2. Cores shall be identified as per IEC: 60502 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per IEC: 60502 (Part-1).

3 CABLE DRUMS

3.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

3.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The employer shall have the option of rejecting cable drums with shorter lengths. Maximum, One (1) number non standard lengths of cable size(s) may be supplied in drums for completion of project.

3.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

3.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

3.5 Each drum shall carry the manufacturer's name, the employer's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

3.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

4 TYPE TESTS

4.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IEC.

4.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-

4.2.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

a) Physical tests for insulation
i) Hot set test
ii) Shrinkage test
b) Physical tests for outer sheath
i) Shrinkage test
ii) Hot deformation
iii) Heat shock test
iv) Thermal stability

4.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following tests-

a) Water absorption (gravimetric) test.
b) Ageing in air oven
c) Loss of mass in air oven
d) Short time current test on power cables of sizes 240 sqmm and above on
i) Conductors.
ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test.

4.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-

4.3.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:

a) Physical tests for insulation and outer sheath
   i) Shrinkage test
   ii) Hot deformation
   iii) Heat shock test
   iv) Thermal stability
b) High voltage test.

4.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following-

a) High voltage test.
b) Ageing in air oven.
c) Loss of mass in air oven.
d) Short time current test on power cables of sizes 240 sqmm and above on
   i) Conductors.
   ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test.

4.4 Terminating/jointing accessories as per IEC 60840:1999/ IEC62067

CHAPTER 6

HTLS CLAMP FITTINGS AND ACCESSORIES

1.0 TECHNICAL DESCRIPTION OF HTLS CLAMP FITTINGS

1.1 General

This section details technical particulars of fittings viz. suspension clamps and compression type dead end clamps for the HTLS Conductor to be supplied by the bidder. Each fitting shall be supplied complete in all respects.

1.2 The fittings shall be suitable for attachment to suspension and tension insulator strings alongwith hardware fittings and shall include 2.5 % extra fasteners and Aluminum filler plugs. Indicative drawings of complete insulator strings alongwith hardware fittings as well as indicative drawings for suspension clamps and dead end clamps are enclosed with this specification. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the designed maximum temperature specified by them for the conductor.

1.3 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Supplier shall be responsible for satisfactory corona and radio interference performance of the materials offered by him.

1.4 Maintenance

1.4.1 The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method.

1.5 Split Pins

1.5.1 Split pins shall be used with bolts & nuts.

1.6 Suspension Assembly

1.6.1 The suspension assembly shall be suitable for the HTLS Conductor, the bidder intends to supply. The technical details of the conductor shall be as proposed by the bidder.

1.6.2 The suspension assembly shall include either free centre type suspension clamp alongwith standard preformed armour rods or armour grip suspension clamp.

1.6.3 The suspension clamp alongwith standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

1.6.4 The suspension clamp suitable for various type of Conductor alongwith standard preformed armour rods/armour grip suspension clamp set shall have a slip strength in conformity with relevant Indian/ International standards.

1.6.5 The suspension clamp shall be designed for continuous operation at the temperature specified by the bidder for conductor.

1.6.6 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any

cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

1.6.7 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

1.7 **Free Centre Type Suspension Clamp**

For the Free Centre Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

1.7.1 **Standard Preformed Armour Rod Set**

1.7.1.1 The Preformed Armour Rods Set shall be used to minimise the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localised heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

1.7.1.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helics shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

1.7.1.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

1.7.1.4 The length and diameter of each rod shall be furnished by the bidder in the GTP. The tolerance in length of the rods between longest and shortest rods in complete set should be within the limits specified in the relevant Indian/ International Standards. The ends of armour rod shall be parrot billed.

1.7.1.5 The number of armour rods in each set shall be as per supplier's design to suit HTLS conductor offered. Each rod shall be marked in the middle with paint for easy application on the line.

1.7.1.6 The armour rod shall not loose their resilience even after five applications.

1.7.1.7 The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

1.8 **Armour Grip Suspension Clamp**

1.8.1 The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminium reinforcements and AGS preformed rod set.

1.8.2 Elastomer insert shall be resistant to the effects of temperature up to designed maximum conductor temperature guaranteed by the bidder corresponding to peak current, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

1.8.3 The supplier shall submit relevant type/performance test certificates as per applicable standard/product specifications for elastomer to confirm suitability of the offered elastomer for the specified application.

1.8.4 The AGS preformed rod set shall be as detailed in clause 1.6.10.4 to 1.6.10.7 in general except for the following.

1.8.5 The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as detailed under clause 1.6.4 and shall not introduce unfavourable stress on the conductor under all operating conditions. The length of the AGS preformed rods shall be indicated in the GTP.

1.9 **Envelope Type Suspension Clamp**

1.9.1 The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.

1.10 **Dead end Assembly**

1.10.1 The dead end assembly shall be suitable for the offered HTLS Conductor.

1.10.2 The dead end assembly shall be of compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted (including angle of pad) should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

1.10.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COM PRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead end assembly is designed for intermittent die compressions it shall bear identification marks 'COMPRESSION ZONE' AND 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones.. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead end assembly before & after compression alongwith tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. These shall be guaranteed in the relevant schedules of bid.

1.10.4 The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

1.10.5 Jumper bolting arrangement between jumper terminal/cone and terminal pad/plate of dead end assembly of tension hardware fittings shall be designed to suit the specification requirement of 1050 A current and shall conform to the relevant Indian/International standards

1.10.6 For composite core HTLS conductor, dead end assembly may inter-alia include collets ,collet housing, inner sleeve etc., suitable for the offered design of HTLS conductor

1.11 **Fasteners: Bolts, Nuts and Washers**

1.11.1 All bolts and nuts shall conform to IS 6639. All bolts and nuts shall be galvanised as per IS 1367 (Part-13)/IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

1.11.2 Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should be provided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.

1.11.3 Nuts should be double chamfered as per the requirement of IS 1363 Part-III 1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size upto M16.

1.11.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

1.11.5 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

1.11.6 Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanised. The thickness of washers shall conform to IS:2016.

1.11.7 The Contractor shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

1.11.8 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

1.11.9 Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

1.11.10 To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc, in-house. The manufacturer should also have proper Quality Assurance system which should be in line with the requirement of this specification and IS-.14000 services Quality System standard.

1.11.11 Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolt shall be 5.6.

1.12 **Materials**

The materials of the various components shall be as specified hereunder. The Bidder shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

1.12.1 The details of materials for different component are listed as in Table No-1.

1.13 **Workmanship**

1.13.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only

such equipment as guaranteed by him to be satisfactory and suitable for 132 KV transmission lines and will give continued good performance. For employer's review of the offered design of clamps/ fittings, the supplier shall submit document/design details of similar type of clamps/ fittings used in past for similar type of HTLS conductor application.

1.13.2 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings under simulated service condition corresponding to continuous operation of conductor at designed maximum temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/performance test certificates as per applicable standards/product specifications to confirm suitability of the offered material.

1.13.3 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

1.13.4 All ferrous parts including fasteners shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanised. The bolt threads shall be undercut to take care of the increase in diameter due to galvanising. Galvanising shall he done in accordance with IS 2629 / IS 1367 (Part-13) and shall satisfy the tests mentioned in IS 2633. Fasteners shall withstand four dips while spring washers shall withstand three dips of one minute duration in the standard Preece test. Other galvanised materials shall have a minimum average coating of zinc equivalent to 600 gm/sq.m., shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard preece test for galvanising.

1.13.5 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanising shall be grade Zn 99.95 as per IS:209.

1.13.6 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.

1.13.7 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

1.13.8 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

1.13.9 All the holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

1.13.10 All fasteners shall have suitable corona free locking arrangement to guard against vibration loosening.

1.13.11 Welding of aluminium shall be by inert gas shielded tungesten arc or inert gas shielded metal arc process. Welds shall be clean, sound, smooth, uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions. Porosity shall be minimised so that mechanical properties of the aluminium alloys are not affected. All welds shall be properly finished as per good engineering practices.

1.14 **Bid Drawings**

1.14.1 The Bidder shall furnish full description and illustrations of materials offered.

1.14.2 Fully dimensioned drawings of the hardwares and their component parts shall be furnished in five (5) copies alongwith the bid. Weight, material and fabrication details of all the components should be included in the drawings.

All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

(i) Dimensions and dimensional tolerance.

(ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.

(iii) Catalogue No.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions

(vii) Design installation torque for the bolt or cap screw.

(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.

- (ix) The compression die number with recommended compression pressure.
- (x) All other relevant terminal details.

1.14.3 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in four (4) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Contractor shall submit thirty (30) more copies of the same drawings to the Owner for further distribution and field use at Owner's end.

TABLE-1

(Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1.	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS-1385	
2.	**For Free Centre /Envelope type clamps**				
(a)	Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	

(b)	Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
(c)	U Bolts	Stainless Steel or High Strength Al alloy 6061/ 65032	Forged & & Heat treated	AISI 302 or 304-L ASTM-B429	
(d)	P. A. Rod	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Heat treatment during manufacturing	ASTM-B429	Min. tensile strength of 35 kg/mm^2
3.	**For AGS type clamp**				
(a)	Supporting House	High Strength Corrosion resistant Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	
(b)	Al insert & Retaining strap	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	High Strength Al. Alloy 4600/ LM-6 or 6061/65032
(c)	Elastomer	Moulded on Al. reinforcement			
4.	**For Dead End Assembly**				
(a)	Outer Sleeve	EC grade Al of purity not less than 99.50%			
(b)	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-2062	
5.	Ball & Socket Fittings,	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
6.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
7.	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
8(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint

		65032/ 63400 Type)			shall not be less than 20 KN
8(b).	Supporting Brackets & Mounting Bolts	High Strentgth Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	

Note : Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparision of material offered viz a viz specified in the bid or else the bids are liable to be rejected.

2.0 ACCESSORIES FOR THE HTLS CONDUCTOR

2.1 General

2.1.1 This portion details the technical particulars of the accessories for Conductor.

2.1.2 2.5% extra fasteners, filler plugs and retaining rods shall be provided.

2.1.3 The supplier shall be responsible for satisfactory performance of complete conductor system along with accessories offered by him for continuous operation at temperature specified for the HTLS Conductor.

2.2 Mid Span Compression Joint

2.2.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor. It must be able to withstand the continuous design temperature of conductor.

2.2.2 The dimensions of mid span compression joint before & after compression alongwith tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. For composite core conductor, suitable sleeve, collets, collet housing may be used for core jointing.

2.3 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium / aluminium alloy and shall have a smooth surface. It shall be able to withstand the designed maximum operating temperature of conductor. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions of Repair sleeve alongwith tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

2.4 Vibration Damper

2.4.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s are installed in the existing line at suspension and tension points on each conductor in each span to damp out aeolian vibration as well as sub- span oscillations,. One damper minimum on each side per sub-conductor for suspension points and two dampers minimum on each side per sub-conductor for tension points has been used for a ruling design span of 320 meters.

2.4.2 The bidder shall offer damping system including Stockbridge type dampers for HTLS conductor for its protection from wind induced vibrations which could cause conductor fatigue /strand breakage near a hardware attachment, such as suspension clamps. Alternate damping systems with proven design offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents including type test reports to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

The damper shall be designed to have minimum 4 nos. of resonance frequencies to facilitate dissipation of vibration energy through inter strand friction of the messanger cable and shall be effective in reducing vibration over a wide frequency range (depending upon conductor diameter) or wind velocity range specified above. The vibration damper shall meet the requirement of frequency or wind velocity range and also have mechanical impedence closely matched with the offered HTLS conductor. The vibration dampers shall be installed at suitable positions to ensure damping effectiveness across the frequency range. The power dissipation of the vibration dampers shall exceed the wind power so that the vibration level on the conductor is reduced below its endurence limit i.e. 150 micro strain. The bidder shall clearly indicate the method for evaluating performance of dampers including analytical and laboratory test methods. The bidder shall indicate the the type tests to evaluate the performance of offered damping system.

2.4.5 The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

2.4.6 The messenger cable shall be made of high strength galvanised steel/stain less steel with a minimum strength of 135 kg/sqmm. It shall be of preformed and postformed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS:4826 for heavily coated wires.

2.4.7 The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.

2.4.8 The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause

premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

2.4.9 The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.

2.4.10 The vibration damper shall be capable of being installed and removed from energized line by means of hot line technique. in addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

2.4.11 The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

2.4.12 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	Description	Technical particulars
1.	Span length in meters	
i)	Ruling design span	320 meters
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters
2.	Configuration	Double Circuit single conductor per phase in vertical configuration.
3.	Tensile load in Conductor at temperature of 0 deg. C and still air	As per Sag – tension calculations
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible dynamic strain ie endurence limit.	+/- 150 micro strains

2.4.14 The damper placement chart shall be submitted for spans ranging from 100m to 1100m. Placement charts should be duly supported with relevant technical documents and sample calculations.

2.4.15 The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free centre type/Armour grip type etc.)

- (4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

2.6 **Material and Workmanship**

2.6.1 All the equipment shall be of the latest proven design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 132KV transmission line application and will give continued good performance at all service conditions. For employer's review of the offered design of accessories, the supplier shall submit document/design details of similar type of accessories used in past for similar type of HTLS conductor application.

2.6.2 The design, manufacturing process and quality control of all the materials shall be such as to achieve requisite factor of safety for maximum working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

2.6.3 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings/ accessories under simulated service condition corresponding to continuous operation of conductor at designed maximum temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/ performance test certificates as per applicable standards/product specifications to confirm suitability of the offered material.

2.6.4 All ferrous parts shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanised as per grade 4 of IS-1573. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be'done in accordance with IS:2629/ IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall have a minimum average coating of Zinc equivalent to 600 gm/sq.m and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Preece test for galvanising unless otherwise specified.

2.6.5 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn 99.95 as per IS:209.

2.6.6 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc.

2.6.7 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localised heating phenomenon is averted.

2.6.8 No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.

2.6.9 Particular care shall be taken during manufacture and subsequent handling to ensure smooth surface free from abrasion or cuts.

2.6.10 The fasteners shall conform to the requirements of IS:6639-1972. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

2.7 **Compression Markings**

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

2.8 **Bid Drawings**

2.8.1 The Bidder shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.

2.8.2 The drawings shall include

(i) Dimensions and dimensional tolerances

(ii) Material. fabrication details including any weld details and any specified finishes and coatings. Regarding material, designations and reference of standards are to be indicated.

(iii) Catalogue No.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions

(vii) Design installation torque for the bolt or cap screw

(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts

(ix) The compression die number with recommended compression pressure.

(x) All other relevant technical details

2.8.3 Placement charts for spacer/spacer damper and damper

2.8.4 The above drawings shall be submitted with all the details as stated above alongwith the bid document. After the placement of award the Contractor shall again submit the drawings in four copies to the Owner for approval. After Owner's approval and successful completion of all type tests, 20 (twenty) more sets of drawings shall be submitted to Owner for further distribution and field use at Owner's end.

3.0 TESTS AND STANDARDS

3.1 Type Tests

3.1.1 On Suspension Clamp

a)	Magnetic power loss test	As per Annexure-A
b)	Clamp slip strength Vs torque test	As per Annexure-A

c)	Ozone Test on elastomer	As per Annexure-A
d)	Vertical damage load & Failure load test	IEC:61284

3.1.2 On Dead end Tension Assembly

a)	Electrical resistance test for dead end Assembly	As per IS:2486-(Part-I)
b)	Heating cycle test for dead end Assembly	As per Annexure-A
c)	Slip strength test for dead end assembly	As per Annexure-A
d)	Ageing test on filler (if applicable)	As per Annexure-A

3.1.3 On Mid Span Compression Joint for Conductor

a)	Chemical analysis of materials	As per Annexure-A
b)	Electrical resistance test	As per IS:2121 (Part-II)
c)	Heating cycle test	As per Annexure-A
d)	Slip strength test	As per Annexure-A
~~e)~~	~~Corona extinction voltage test (dry)~~	~~As per Annexure-A~~
~~f)~~	~~Radio interference voltage test (dry)~~	~~As per Annexure-A~~

3.1.4 Repair Sleeve for Conductor

a)	Chemical analysis of materials	As per Annexure-A
~~b)~~	~~Corona extinction voltage test (dry)~~	~~As per Annexure-A~~
~~c)~~	~~Radio interference voltage test (dry)~~	~~As per Annexure-A~~

3.1.5 Vibration Damper

a)	Chemical analysis of materials	As per Annexure-A
b)	Dynamic characteristics test*	As per Annexure-A
c)	Vibration analysis	As per Annexure-A
d)	Clamp slip test	As per Annexure-A
e)	Fatigue tests	As per Annexure-A

f)	Magnetic power loss test	As per Annexure-A
~~g)~~	~~Corona extinction voltage test (dry)~~	~~As per Annexure-A~~
~~h)~~	~~Radio interference voltage test (dry)~~	~~As per Annexure-A~~
i)	Damper efficiency test	As per IS:9708

*Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers(permitted as per clause 2.4.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.1.6 Type tests specified under Clause 3.1.1 to 3.1.5 shall not be required to be carried out if a valid test certificate is available for a same design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of NEA/POWERGRID or Utility.

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

3.2 Acceptance Tests

3.2.1 On Both Suspension Clamp and Tension Assembly

a)	Visual Examination	As per IS:2486-(Part-I)
b)	Verification of dimensions	As per IS:2486-(Part-I)
c)	Galvanising/Electroplating test	As per IS:2486-(Part-I)
d)	Mechanical strength test of each component	: As per Annexure-A
e)	Mechanical Strength test of welded joint	: As per Annexure-A
f)	Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings	: As per Annexure-A

3.2.2 On Suspension Clamp only

a)	Clamp Slip strength Vs Torque test for suspension clamp	As per Annexure-A
b)	Shore hardness test of elastomer cushion for AG suspension clamp	As per Annexure-A

c)	Bend test for armour rod set	As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
d)	Resilience test for armour rod set	As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
e)	Conductivity test for armour rods set	As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11

3.2.3 On Tension Hardware Fittings only

a)	Slip strength test for dead end assembly	As per Annexure-A
d)	Ageing test on filler (if applicable)	As per Annexure-B

3.2.4 On Mid Span Compression Joint for Conductor

a)	Visual examination and dimensional verification	As per IS:2121 (Part-II), Clause 6.2, 6.3 7 6.7
b)	Galvanising test	As per Annexure-B
c)	Hardness test	As per Annexure-B
d)	Ageing test on filler (if applicable)	As per Annexure-B

3.2.5 Repair Sleeve for Conductor

a)	Visual examination and dimensional verification	As per IS:2121(Part-II) Clause 6.2, 6.3

3.2.6 Vibration Damper for conductor

a)	Visual examination and dimensional verification	As per IS:2121(Part-II) Clause 6.2, 6.3 & 6.7
b)	Galvanising test (i) On damper masses ii) On messenger cable	As per Annexure-B
c)	Verification of resonance frequencies	As per Annexure-B

d)	Clamp slip test	As per Annexure-B
e)	Clamp bolt torque test	As per Annexure-B
f)	Strength of the messenger cable	As per Annexure-B
g)	Mass pull off test	As per Annexure-B
h)	Dynamic characteristics test*	As per Annexure-B

*Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers(permitted as per clause 2.4.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.3 Routine Tests

3.3.1 For Hardware Fittings

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

3.3.2 For conductor accessories

a)	Visual examination and dimensional verification	As per IS:2121(Part-II) Clause 6.2, 6.3 7 6.7

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	As per Annexure-A
c)	Chemical analysis, hardness tests and magnetic particle inspection for forging	As per Annexure-A

3.5 **Testing Expenses**

3.5.1 As indicated in clause 3.1.6 no type test charges shall be payable.

3.5.2 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

3.5.3 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/CIF Price.

3.5.4 In case of failure in any type test, repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/ Owner's representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative/Inspector does not find material & facilities to be ready for testing the expenses incurred by the Owner's for redeputation shall be deducted from contract price.

3.5.5 The Contractor shall intimate the Owner about carrying out of the type tests alongwith 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 Owner will arrange to depute his representative to be present at the time of carrying out the tests.

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 Owner. 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 Owner.

3.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner'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 Owner 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 comply with the specifications.

3.7.3 The Owner 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 Owner.

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 Owner , only after which the commercial production of the concerned material shall start.

3.8.2 Copies of acceptance test report shall be furnished in atleast six copies. One copy shall be returned, duly certified by the Owner, only after which the materials will be despatched.

3.8.3 Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Owner'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 Owner.

3.9 **Inspection**

3.9.1 The Owner'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 Owner 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 despatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be despatched 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, vibration damper, spacer/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 despatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stencilled on it in indelible ink.

3.11 **Standards**

3.11.1 The Hardware fittings; conductor and earthwire 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 hardware fittings; conductor and earthwire 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: 209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage (132 KV) and above	IEC:1089-1991 BS:215-1970
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.		Ozone test on Elastomer	ASTM- D1 171
9.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
10.	IS:4826	Galvanised Coating on Round Steel Wires	ASTM A472-729 BS:443-1969
11.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO : 1460 (E)
12.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437 NEMA:107 CISPR
13.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
14.	IS:10162	Specification for Spacers Dampers for Twin Horizontal Bundle Conductors	

The standards mentioned above are available from:

Reference Abbreviation	**Name and Address**
BS	British Standards, British Standards Institution 101, Pentonvile 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.

ANNEXURE - A

1.0 Tests on Hardware Fittings

1.1 Magnetic Power Loss Test for Suspension Assembly

One hollow aluminium tube of diameter of the HTLS conductor shall be used for the testing. An alternating current over the range of 700 to 1200 amps shall be passed through the tube. The reading of the wattmeter with and without suspension assemblies alongwith line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to 1050 amperes shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

1.2 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS:2486 (Part-1) except that both uniformity of zinc coating and standard preecee test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.3 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.

1.4 Mechanical Strength Test of Welded Joint

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

1.5 Clamp Slip Strength Vs Torque Test for Suspension Clamp

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be as indicated in the GTP.

1.6 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.

ii) Number of cycle: 100

iii) Slip strength test shall also be carried out after heating cycle test.

1.7 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.

1.8 **Ageing Test on Filler (if applicable)**

The test shall be done in accordance with Grease drop point test method. The specimen should be 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.

1.9 **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.

1.10 **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.

1.11 **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 iniiternationally 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.

1.12 **Ozone Test for Elastomer**

This test shall be performed in accordance with ASTM D-1171 by the Ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test compleion, there shall be no visible crack under a 2 x magnification.

2.0 Tests on Accessories for Conductor

2.1 **Mid Span Compression Joint for Conductor**

(a) Slip Strength Test

The fitting compressed on conductor shall not be less than one metre in length. The test shall be carried out as per IS:2121 (Part-ii)-1981 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/ earthwire relative to the fittings and no failure of the fit tings during this one minute period.

(b) **Heating Cycle Test**

Heating cycle test shall be performed in accordance with IS 2121 (Part-II-1981) with following modifications:-

i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.

ii) Number of cycle: 100

iii) Slip strength test shall also be carried out after heating cycle test.

2.2 **Vibration Damper for Conductor**

(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 to 1.4/d) Hz, where d is the conductor diameter in meters. The damper assembly shall be vibrated verticially with a $\pm$ 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at ± 0.5mm 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 damper 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 0.0991 f to 0.495 f Kgf/mm limits, where f is frequency in Hz.

(iv) The above mean phase angle response curve shall be between 25^{o} to 130^{o} 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 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 taken into account 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 shall be taken from Sag & Tension calculation (o deg. C & no wind condition and 320 m ruling span) for a span ranging from 100 m to 1100.

(ii) The self damping factor and flexural stiffness (El) for 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 point 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 0 deg & no wind condition and ruling span 320 from sag –tension calculation 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.

(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 ± 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 $\pm$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 guar anteed % 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 **Magnetic Power Loss Test for Vibration Damper**

The sample involving ferrous parts shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. The test should be carried out at various currents ranging from 700 to 1200 amperes per sub-conductor. The magnetic power loss at various currents should be specified in tabulated graphical form. The difference between the power losses without and with sample at room temperature shall be limited to value guaranteed by the supplier for 1050 amperes current (rms). The losses shall be determined by averaging the observations obtained from atleast four samples.

2.7 **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.

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 Owner 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 Owner in Quality Assurance Programme.

ANNEXURE-B

Acceptance Tests

1 Mid Span Compression Joint for Conductor

(a) Hardness Test

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

2. Vibration Damper for Conductor

(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 2.2 (c) (ii) of Annexure-A.

(c) Clamp Bolt Torque Test

The clamp shall be attached to a section of the conductor/earthwire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.2 (c) (i), Annexure-A.

(d) 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

(e) 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.

(f) Dynamic Characteristics Test

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

Vibration Damper of Conductor
- 1 Sample for 1 000 Nos. & below
- 3 Samples for lot above 1 000 & upto 5000 nos.

- 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 5 Hz to 40 Hz.

(ii) If all the individual curve 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.

Chapter 7

Technical Specification of Hot line equipments for 132/220/400 kV Transmission Lines

1.0 **Scope of the supply:**

The scope includes design, manufacture, testing and supply of Tools & Tackles for Live Line Working on 220/400kV S/C & D/C Transmission lines with bare hand methods as per the requirement specified herein.

The successful bidder shall impart training on different live line maintenance operations for a batch about 20 personnel, by a certified Original Equipment Manufacturer (OEM) Experts for 15 working days at site.

1.1 Tools & Tackles required for successful accomplishment of the following Live Line maintenance/Operations in Transmission Lines of 220/400KV:

i) Changing Insulator string on Single Circuit Tangent/ Suspension towers in I & V string configuration.

ii) Changing insulator string on Double Circuit Tangent/ Suspension towers in I & V string configuration in all the phases of vertical configuration.

iii) Changing of Pilot Strings in Single/Double circuit angle/ Dead End Towers.

iv) Changing of Tension Insulator string on Single Circuit angle/ dead end Towers.

v) Changing of Tension Insulator string on Double circuit angle/ dead end Towers in all the phases of vertical configuration. .

vi) To repair or replace Hard wares like corona ring/ arcing horn/ vibration dampers.

vii) To replace or re-adjust the Spacer damper/ Bundle spacers in twin conductors.

viii) To repair the damaged conductors by installing suitable pre-formed Aluminum alloy rods.

2.0 **OEM and Spares:**

2.1 The original equipment under this specification, i.e Tools for Live Line Working on 220 / 400KV voltage level shall be designed, manufactured and tested as per international standards like IEC 60895 and IEC 60855. The scope includes successful demonstration of the tools in 220kV / 400kV transmission lines by the OEM experts.

2.2 List of spares required for operation/ maintenance of the equipment for three years is to be submitted along with the bid in separate schedule along with commercial bid. Cost of spares shall not be considered for evaluation of bid.

3.0 **Weights and Measures**

All weights and measures shall be in "System International" (S.I.) units. All bolts, nuts, washers, rivets etc. shall be of metric sizes only.

4.0 **Guaranteed Technical Particulars**

Documents/ catalogue/booklets/technical data and any other relevant information

pertaining to the tools and under the scope of supply shall be submitted by the bidder in their technical bid (first stage) at the time of submission of bid.

5.0 **Tests and Standards**

5.1 Bidder shall carry out all the tests and ensure the design, quality of the material used and the performance of each and individual equipment/ tool/ component covered under the scope of this specification. All tools shall be subjected to the test as indicated in IEC 60855, IEC 60832 and IEEE 978-1984. The acceptance norms for all the tests shall be the values guaranteed by the Bidder in the guaranteed technical particulars in prescribed schedule of proposal or the acceptance values specified in this specification whichever is more stringent for that particular test. The Bidder shall also specify the governing International/ National standards for these tests and their acceptance norms.

Each Tool under this specification should have product ID i.e., serial no, product code, batch/lot number, and SWL (safe working load) displayed.

5.2 Bidder shall indicate the laboratories/ works in which they propose to conduct the above test. They shall ensure that the tests can be completed in the proposed laboratories within the time schedule guaranteed by them.

5.3 **Tests during Manufacture**

5.3.1 Representative test pieces/ suitable samples shall be taken from all insulating materials and will be subjected to high voltage test for determination of all electrical properties, viz. withstand, flashover impulse etc. Electrical resistance test shall also be carried out wherever applicable.

5.3.2 Mechanical properties of all hot line tools should be determined by carrying out mechanical strength test, bending strength test and any other tests, which are required to establish the mechanical/electro-mechanical strength of the material used.

5.3.3 Suitable test should be carried out for determination of the chemical properties of the insulating material.

5.3.4 All load bearing welded joints shall be subjected-to magnetic particle examinations/ dye penetration test/radiography test and this shall be carried out after stress relieve.

5.4 **Type Tests**

5.4.1 All type tests as specified in the latest revision of IEC 60855, IEC 60832 and IEEE 978-1984, shall be carried out by the Bidder. However, the Bidder shall submit the detailed testing program and test procedure along with the offer. The Bidder shall also indicate any other tests, which are required to be carried out to ensure the design and the National/ International Standards according to which these tests are to be carried out.

5.4.2 After the award, the Bidder shall intimate the Purchaser, at least 30 days in advance, the exact program for testing, giving commencement and completion dates, the place of testing etc. POWERGRID may depute its representative to witness the type testing. After the successful testing of the equipment, the

Bidder shall submit six copies of the detailed test report to the Purchaser for approval.

5.5 **Acceptance Tests:**

5.5.1 Acceptance tests shall be carried out as per IEC 60855, IEC 60832 and IEEE 978-1984 applicable to different tools.

5.6 **Maintenance Criteria for Live Line Tools:**

The bidder shall also submit the schedule regarding the type of maintenance/ testing to be carried out periodically on the Live Line Tools to ensure their healthiness. A check list for condition monitoring of tools supplied shall also be furnished by the bidders.

5.6.1 **Operation & Maintenance Manuals**

A copy of Operation & Maintenance Manuals and other related technical literature with Items/Equipment shall be supplied by the bidder at the time of delivery of items/equipment.

6.0 Technical Information for 400 kV system

6.1 Electrical System Data for 400 kV system

a)	Nominal voltage	400 kV
b)	Maximum System Voltage	420 kV
c)	BIL (impulse)	1550 kV (peak)
d)	Power frequency withstand Voltage (wet)	680 kV (r.m.s.)
e)	Switching surge withstand voltage(wet)	1050 kV (peak)
f)	Minimum corona extinction voltage at 50 Hz AC System under dry condition	Not less than 320 kV (rms) phase to earth
g)	Radio interference voltage at one MHz for phase to earth voltage of 305 kV dry condition	Not exceeding 1000 µ volts
h)	Ruling design span/Normal Span	400 m
i)	Weight span	600 m

For other voltage level refer GTR, section 2

The minimum live metal clearance provided between the live parts and steel work of superstructure shall be as per IEC or other international standard as given in following table:

6.2 Particulars of conductor and Earth wire used for 400 kV Transmission lines

Currently the 132kV line is strung with ACSR Bear, ACSR Cardinal, ACSR Duck, ACSR Wolf, ACSR Panther, ACSR Zebra,

220kV: ACSR Moose twin conductor, ACSR Bison

400kV: ACSR Moose Quad

7.0 Technical Description of Live Line Tools and Tackles:

7.1 Tools and tackles envisaged under this specification should be suitable to take up live line maintenance on 132 / 220 / 400KV towers/ insulators etc so that the live line maintenance could be carried out smoothly meeting the required electrical clearances for above system and mechanical safe loading capabilities.

7.2 The Live line tools shall be made up of suitable epoxiglass Insulating material and shall have sufficient di-electric and mechanical strength to use on upto 400KV system. The length, diameter of hot sticks shall be suitable for live line maintenance upto 400 kV transmission line towers. All metal parts shall be made of high strength heat treated aluminum alloy/forged steel and free from sharp edges. All ferrous parts of the equipment and tools shall be hot dip galvanized as per international standard.

7.3 Spliced adjustable Strain Pole Assembly

7.3.1 Spliced Two pole strain carrier Assembly shall be used to relieve the strain from the energized lines. It shall be suitable for use on both suspension and dead end insulator strings. The strain carrier shall have sufficient mechanical and di-electric strength to safely take the electrical and mechanical stress of live bundle conductors i.e. up to 6000 Kg minimum. The assembly shall consist of suitable dia and length of spliced hot sticks i.e. hot end pole and cold end pole with required clevis finish, different type of yoke plates for replacement of suspension/"V" string and Dead end Insulator string in 400KV lines. The set shall consist of required numbers of suitable size strain jack, Trunion, Reversible Ratchet wrench, Bail Hanger and steel pins etc.

7.3.2 The strain carrier shall be light weight and have a spliced pole length required for replacement of different type of insulator strings.

7.3.3 Trunnion shall be suitably designed so that it can be fitted on the take up screw of pole carrier for uniform distribution of load on to the cold end yoke plate.

7.3.4 The cold end yoke plate shall include a chain assembly for anchoring the cold end yoke plate to the cross arm securely.

7.3.5 All metal parts shall be made of high strength heat treated aluminum alloy except the yoke plates. Yoke plates shall be made of high strength aluminum plate with a safe working capacity of 7500 Kgs.

7.4 Insulator Cradles

7.4.1 EHV Trough-Design Insulator Cradle Assembly:

Trough-design cradle shall be used for lowering the "V" insulator strings to ground on 400 kV transmission lines after removing from its original position. Required nos. of Epoxiglass Hot sticks shall be of suitable length and diameter with heat-treated aluminum castings ends and steel hardware. It must be provided with

suitable retaining plate so that, the cradle shall hold the insulator string secured thus preventing the accidental dropping of the string. The diameter of the cradle shall be made in such a way to accommodate upto 25 nos (23 + 2 additional insulator) of 280 mm width insulators.

For easy maneuvering of insulator laden cradle, one U-shaped ball, with a turn around on both the ends and an eye at the center for fixing link stick, shall be provided. For installing and removing the dead end tools from insulator yokes, hook shall be provided.

7.4.2 EHV Side Opening Insulator Cradle:

The side opening cradle shall permit removal of anyone string in Dead end bundles. The EHV side opening cradles shall be made up Epoxiglass sticks of suitable length, quantity and diameter and capable of meeting the required dielectric and mechanical strength of 400KV Dead end strings. One end of the stick shall be fitted with suitable butt rings to hold it remotely if required. The cradle should be provided with required numbers of "J" shaped Epoxiglass hooks, insulator retaining plates, Insulator spacer etc.

The EHV side opening cradle shall be designed to allow the dead end insulator string to be removed and lowered to the ground while in the cradle, with the use of the tower boom, special snatch blocks, special rope and capstan hoist. It shall also allow for the reverse procedure for installing the dead end insulator string.

7.5 Swivel Boom Assembly:

7.5.1 Heavy duty swivel boom shall be used to swing an insulator cradle into the structure for repair. It shall also be designed to allow for lowering the cradle insulator to the ground for repair or replacement and for reinstalling the insulator string by reverse procedure.

7.5.2 The heavy duty swivel boom shall be made of insulated mast pole, side brace poles with one end swivel rings(For Tri-pad arrangement), suitable square boom meeting required dielectric and mechanical strength for 400KV systems, while replacing dead end insulator strings. Attachment hardwares like boom base, square clamp, tower mounting brackets, rigging tools like ratchet hoist of required capacity and other clamps required for mounting & operating the complete boom assembly on tower shall be supplied. The complete assembly shall be designed for 1800 Kg. min. capacity.

7.6 Spliced Heavy Duty Hook Ladder Assembly:

7.6.1 Insulated Swivel Hook Heavy Duty Ladder shall be used as a platform for diversified applications like positioning of Hot man at the required location while carrying out live line maintenance. The ladder should consist of Top, Middle and Bottom section of suitable length. The minimum total length of the ladder shall be 12.0 meters, but shall be suitable to use for lower voltage level also. The hook shall be of minimum 200 mm size and fitted with safety chains. The ladder should be made up insulated material of required dielectric & mechanical strength. The side rails of sufficient diameter and numbers shall be provided in the ladder. The ladder shall be supplied with required Locking Keys with security Click pins made up of high strength galvanized steel.

7.6.2 Attachments for Ladder:

In order to mount the insulated ladder on the tower suitable vertical or horizontal attachment hard wares shall be supplied along with the ladder. These attachments shall be mechanically strong and can be used depending on the application. The attachments includes ladder clamp, ladder double clamps, Horizontal Ladder Base bracket assembly, Vertical Ladder base bracket assembly with yokes, 2 nos. Insulated spreader bar and 4 nos. Insulated swivel stick of minimum 4000 mm length of suitable diameter.

7.6.3 Platform Ladder:

Foldable Insulated platform ladder for the cold man to position himself, while removing the dead end insulator assembly. The ladder should be supplied along with required swivel hook and safety chains.

7.7 Universal Pole:

7.7.1 The universal pole shall be designed for use as a hot stick handle for universal tools. Universal pole of required length and diameter shall be made of Epoxiglass. The ends should have universal head so as to attach any universal tool. The ends shall be made of light weight cast aluminum, both spline and threaded hex.

7.7.2 The spline universal tool shall fit under the thumb screw over the spline on the universal pole for a rigid hot stick tool attachment. The spline shall allow angling up to 90° of the tool with respect to the pole. A universal adapter shall be provided between the pole and tool to obtain any desired angle.

7.7.3 It shall be equipped with "C" shaped hook for hanging the pole on a conductor while it is not in use.

7.7.4 Different length Universal Poles shall be supplied.

7.8 Spliced Wire Tongs:

7.8.1 The wire tong shall be made of epoxiglass and designed to use them for holding and moving live line conductors beyond a clear working area to work on insulators and tower cross arms by live line crew. Suitable clamps, wire tong bands, attachments, saddles and lever lifts shall be provided along with wire tongs for adapting to the mechanical requirements of Transmission lines.

7.8.2 Wire tong jaws shall have the provision to be opened or closed by rotating the pole while the jaws are in contact with the conductor. A swivel ring, into which the rope blocks will be attached to assist in raising and lowering the tong, shall be at the opposite end of the pole.

7.8.3 The wire tong body shall be made of Epoxiglass and shall be free from moisture absorption. Fittings shall be made of heat-treated Aluminum alloy and shall be such that easy dis-assembly can be done at the field in case of repairing.

7.8.4 The jaw on the head of the wire tong shall be suitable for different size of ACSR Conductor.

7.8.5 Wire tongs/spliced wire tongs of various length are required to carry out different live line maintenance in single circuit/ double circuit towers as indicated in the specification.

7.9 Insulated Strain Link Stick:

7.9.1 The strain link stick works as an insulating bridge between the rope blocks and come along clamp/ live conductor on tension tower. The hooks and ferrules shall be made of heat-treated aluminum alloy and the butt rings of high quality forged steel.

7.9.2 The butt swivel shall be provided so that it can spin freely on ball thrust bearing eliminating possibility of dropping the conductor as the rope unwinds and twists when drawn taut.

7.9.3 The jaw sizes shall be suitable for accommodating different size of ACSR Conductor. The edges of the jaws shall be smoothly rounded off to prevent damages on conductor surface.

7.9.4 Strain line sticks of different lengths are required to carry out different live line maintenance works on single circuit/ double circuit towers.

7.10 Insulated Swivel Sticks:

The swivel sticks shall be made of Epoxiglass material of required length and dia to use in various live line maintenance applications. Both ends shall be provided with butt rings made up of high quality forged steel, for attaching rope blocks or hand lines. These butt swivels should spins freely. Different lengths swivel sticks shall be supplied.

7.11 Trolley Pole Suspension Insulator Tool:

The insulated trolley pole shall be used to roll out a suspension insulator string from/ to the tower structure so as to replace the damaged insulator strings. Besides dielectric strength, the pole should be designed for a safe mechanical load. This pole shall be placed horizontally under the tower cross arm using standard tower type wire tong saddles. The tandem trolley wheel shall fit on insulated trolley pole of suitable length for voltage upto 400 kV live line work. The trolley pole is same as one of the mast pole in Heavy Duty Boom Assembly used for dead end insulator changing. The suspension insulator tool shall be used to support the string of insulators as they are rolled from/ to the tower, a heavy duty fork, on the end of the tool, should be fitted under the top insulators so that the entire string could be lifted free by a slight downward pressure on the opposite end of the pole.

7.12 Insulated Static Ground:

It is used to eliminate static charges arising during live line maintenance works. It should have the adjustable jaws to fit into the insulator ball-caps of various sizes used in Transmission system. Insulator static ground shall be supplied along with grounding cable and flat face clamp.

7.13 Insulated Telescopic Hot Stick:

Insulated Telescopic Hot Stick shall be made of Epoxiglass with minimum expandable length of 9.0 meters with scale printed in meters. It shall be of collapsible type and designed to measure the distance of live conductors.

7.14 All Angle Cog Wrench:

It shall be made of Epoxiglass of suitable length & diameter and have gear mechanism to use the wrench in live condition remotely. The inner rod shall also be made of epoxiglass of suitable diameter. The hand grip may be aluminum alloy. The cog housing shall be bronze alloy and gears shall be of hardened steel.

7.15 Hotline tool trailer:

7.15.1 The hotline tool trailer shall have a minimum tools transportation capacity of 2000 kg. The trailer should as compact as possible and should be able to accommodate all the tools supplied under this specification. The ladder and Square Boom can be loaded on top of the trailer. The length and width of the trailer should be designed to easily toe on roads. The overall gross weight (including tools) shall not exceed 5000 kg. It should have a hydraulically operated lid with a safety device to prevent accidental closing.

7.15.2 The trailer body shall have dust and water seals and a heavy channel rear bumper with kid plate. The body shall be of cold rolled steel and rust proof. Key-locks at rear and front storage boxes shall be provided. A thermostat and a heater shall be installed inside the body and shall be set such as to maintain a uniform temperature between 30°C and 40°C. The operating voltage for heater shall be 230 V, 50 Hz. The trailer shall contain two ladder rack, two universal tool-mounting boards and suitable hooks and hold-down straps. All the inner and outer surfaces of the body shall be painted with the good quality, moisture & temperature resistant paint. Alternatively the body of the trailer shall be made up of fiber.

7.15.3 Necessary towing arrangement for fixing up the trailer body with a vehicle shall be made. The towing group shall consist of pintle-eye hitch having facilities of adjustable height and length, safety chains and jack mounted castor wheel.

7.15.4 The trailer shall have within itself automotive type wiring suitable for movement on highways/ village roads. Mounting bracket and heater receptacle for electrical connections to two vehicle and 12 volt rated dual taillight-stoplight combination shall be included in the electrical system of the trailer.

7.15.5 The trailer shall serve the dual purpose of transporting as well as storing of Hot Line Tools for which necessary compartments, racks, bins along the sides of safe keeping shall be provided. Required numbers of adjustable plastic covered hooks, platform hooks and extra accessories boxes shall be provided with the trailer.

7.15.6 The trailer shall be provided with tandem axle wheels and tubeless tyres of International standard size. The wheel hubs should be designed in such a way to fit tubeless tyres available in Indian market in future.

7.16 Tackles, Saddles, Capstan, Hand Tools and Ropes:

7.16.1 Universal Tool Kit:

This kit includes complete set of tools & attachments required for hotline maintenance trailer.

7.16.2 Capstan Hoist:

The capstan hoist shall work on a petrol engine as well as 230V, 50Hz electric supply. It shall have a lifting capacity of 1800 kg for 3 to 5m/ minute. It shall be supplied with structural brackets to fit on towers. It shall be complete with all accessories e.g. pulleys, rope, drums etc. necessary for proper operation. The capstan hoist with mounting brackets shall be lightweight and portable. Capstan shall be complete with material handler and suitable portable generator, in case electric hoist is offered. The capacitor ratings used in capstan should be of international standard.

7.16.3 Tower Type Wire Tong Saddle and Extensions:

The saddle is meant for fixing the wire tong with the angle sections of the tower. It shall be made of lightweight aluminum alloy of adequate mechanical strength. Wheel type tightener shall be used. It shall be made suitable for use on any type of steel tower construction.

Wire tong saddle extension made of heat-treated aluminum alloy shall also be used along with the saddle. One end of the saddle extension shall have a provision for fitting on saddle and the other end shall be suitable for fixing with the pole clamp. It should provide an extension of 100 mm and tested for safe working load.

7.17 Pole Clamps:

Pole Clamps shall be used for gripping the wire tong securely with the tower type wire tong saddle and also shall have a provision for loosening to permit the wire tong to slide while positioning a conductor. The inside surface of the clamp shall be smooth with round edges so that it shall not damage the surface of the wire-tong. The pole clamp shall be suitable for the size of the wire tongs to be used.

7.18 Nylon Rope Blocks:

The rope block is meant for holding the conductor or other equipment under tension so as to loosen the component on which maintenance is to be done. The shells and sheaves are to be made of high dielectric, fiber filled natural nylon. The shaft shall be of silicon bronze and the sheave bearing oil impregnated bronze. The block is to be rated for 1600 Kg and the dielectric strength in dry weather shall be minimum 30 KV between the bearings and the mounting bolt nut. The rope blocks shall be three sheave type and be suitable for a rope size of 12 mm composite fiber braided ropes. The pair of blocks with minimum 45 meter length, 12mm composite fiber rope also to be supplied.

7.19 Tool Hanger & Clamp:

It is necessary to hang the sticks on wires and so it should have provision for 'C' type hanger which can be fitted to the sticks by tightening screw and shall be suitable for use on different size of poles.

7.20 Live Line Tools Racks:

Pair of tools rack shall be compact and collapsible with tri-pod type legs. The folding tripod-like legs of the rack shall look in the fully open or fully closed position. Rack shall be made of arms with tough plastic coat with center mast. All metal parts below the plastic shall be galvanized or of bronze. Each tool rack shall have 12 arms to accommodate up to 12 tools. Poles of 75mm diameter shall easily fit on the arm.

7.21 Grip All Clamp Stick Assist Ring:

Grip-all assist ring shall help in holding the Grip-all clamp stick at suspension point for attaining safe working clearance.

7.22 Swivel Hook Ladder:

Epoxiglass swivel hook ladder shall be of 6 M length (minimum). It shall be designed with suitable spacing to work on 400KV lines.

7.23 Ratchet Wrench:

This Ratchet Wrench shall be used for tightening bolts nuts of hardware fittings on energized transmission and distribution lines etc. The Ratchet Wrench should have universal mounting for attaching it to universal pole.

Set of Extra double deep hexagonal shape sockets of standard sizes shall be provided with standard Ratchet Wrench. It shall have standard square opening at the base for fittings on wrenches. The diameter of the bolts fitted in the insulator strings vary from 10mm to 32mm

7.24 Tool Bucket:
Made up good quality material to send the tools to line men working at live conductors. Suitably designed to carry hand line tools and other spares as per the site requirement

7.25 Live Line Maintenance Ropes confirm to IEC Standard:

7.25.1 Composite Fiber Braided rope:

Composite Fiber Braided rope shall be made of Polyester fibres plied over polyolefin fibers in each of the 12 strands. It shall be of high dielectric strength and resistant to mild dew, rot and chemical damage. The fibers shall be resistant to moisture absorption.

Braided rope shall be of standard configuration. It shall have low stretch, firm, round construction and shall give excellent gripping power on capstans. The rope should be supplied with good quality drums.

Different size of ropes as shall be supplied.

7.25.2 Poly Dacron Rope:

To be used as bull line live maintenance works. Shall be three strand flexible combinations of synthetic fibers with excellent dielectric properties and shall be free from chemical damages. It shall be usable on capstans and fine sliding hitches.

7.25.3 Poly Propylene Ropes:

It shall be designed in three strand construction with high dielectric and mechanical strength and resistance to moisture. It shall be used as hand line in live line maintenance works. Different size of ropes shall be supplied.

7.26 Hot man Accessories, safety and Testing Equipments confirm to IEC 60895:

7.26.1 Conductive Suits:

Conductive suit shall be made of conductive material and allow the lineman to equalize his potential with the electrical field of the energized system where maintenance work is to be performed. The conductive suit or trousers and jacket-hood, with drawstring, large enough to fit over safety helmet and the grounding strap of the jacket and pants tied together to prevent electrical separation of both. Suit shall be made up from blend of Nomex aramid flame with zepal finish to repel water.

7.26.2 Conductive Gloves:

The gloves are to be made of conductive material, same as that of suit. It shall be extremely strong and tear resistant.

7.26.3 Conductive Socks:

These socks are to be made with conductive threads, interwoven for the protection of line man.

7.26.4 Conductive Boots:

It should drain static charges to the tower body, thus eliminating annoying shocks to linemen working in high voltage atmosphere. It shall be provided with adjustable leg band with conductive strap. Electric flow shall continue through metal heel to contact with conductive heel pad, in sole, mid sole and outer sole. The upper shall be made up of high oil content/quality leather. It shall confirm to ANSI Class 75 steel toe footwear and ANSI specification Z41.

7.26.5 Static Belt:

Static belt shall be made from conductive suit material and to be used by Hot man while working in live condition. This is for additional safety when two or more hot men are deployed for live line works. Its length shall be 1.5 Meters (Minimum) and width of 20 mm.

7.26.6 Hot Stick Tester:

The hot stick tester shall be used for testing the healthiness of hot line tools before use. It shall be suitable for testing all types of hot sticks regardless of size and insulating material. It shall measure true leakage current, independent of stray capacitance currents, and shall operate at ambient temperatures up to 55°C. It shall be portable and light in weight, easily operated by one man. It shall be safe for operation and will not damage a hot stick even when it has absorbed excessive moisture. The supply voltage for hot stick tester shall be 230V, 50Hz only.

7.26.7 Hot Clamp:

Hot clamp shall have serrated jaws for main line connection. It shall have spring loaded and snap on type clamp to ensure ease of installation. It is to be used to make and maintain firm contact with live potential by the hot man.

7.26.8 Ladder Monitor Kit:

It is a leakage current monitoring instrument. It may be digital or analog, with a capacity to measure the leakage current ranging from 1 to 1000 microamperes. It shall be portable and battery operated. Required clamps, co-axial cable and carrying case shall be included in the supply.

7.26.9 Epoxiglass Cleaning Kit:

The kit used to restore the electrical properties of the Epoxy glass sticks shall consist of Moisture eater, abrasive cleaning pads, Gloss restorer and hot stick wiping cloth.

Moisture Eater: Able to remove dirt, tar, grease, light metal rubbings and old surface coatings without harming the epoxy glass materials during general maintenance of the live line tools.

Abrasive cleaning pads: To remove the contaminations on the tools and to remove the oxide/corrosion on metal parts.

Gloss Restorer: The epoxiglass bond patching kit shall be used to repair small surface ruptures on Epoxiglass Hot sticks, to install new ferrules on Epoxiglass poles, or to assist in replacing rungs on Epoxiglass ladders. The kit shall consist of a tube of hardener and a tube of resin that are to be mixed immediately before repairs are made. A mixing stick shall also be provided. The bidder shall supply mixing and application instructions.

Hot Stick Wiping Cloth: Made from silicon impregnated cloths and to be used to wipe out mildly contaminated epoxy glass and provide thin protective film coating on the surface of the tool.

7.26.10 Dry Film Tool Lubricant:

The dry film lubricant shall be offered as a lubricant for all bearing surfaces, sliding and threaded live line tools/hard wares. It shall be made from molybdenum disulphide and applied as aerosol packaged spray material, and shall be air dry and bond to the tool surface almost instantly. It shall not contain any graphite, oil, grease wax or silicone and shall be capable of withstanding pressure beyond the yield point of metal. It shall have excellent dielectric property.

7.27 Common Line Man Tools for Live Line Maintenance Works:

7.27.1 Snatch Block with Forged Steel Hook:

Light weight single way fiber pulley block (snatch Blocks), suitable for 16mm PP Rope, cast-aluminum housing and sheaves, with a hinged cotter lock yoke and forged steel hook with safety latch and factor of safety of 1:3.

Safe Working Load : 400 Kgs(min)
Max. Weight : 1 Kg

7.27.2 Snatch Block With Forged Meat Hook

Light weight single way fiber pulley block (snatch Blocks), suitable for 16mm PP Rope, cast-aluminum housing and sheaves, with a hinged cotter lock yoke and forged meat hook with safety latch and factor of safety of 1:3

Safe Working Load : 400 Kgs (min)
Max. Weight : 1 Kg

7.27.3 Snatch Block of 1000Kg Capacity:

Light weight single way fiber pulley block (snatch Blocks), For 16mm PP Rope, cast-aluminum housing and sheaves, with a hinged cotter lock yoke and forged steel hook with a safety latch

Safe Working Load : 1000 Kgs (min)
Max. Weight : 3 Kgs

7.27.4 Fall Arrester:

Shock absorbing rope lanyard of 20mm tubular nylon web with polyester shock absorbing core, with suitable snap hooks at both ends for attaching with the Dorsal D-Ring of the harness and also for fixing with a suitable anchoring point. Life line shall be of 2 meter length. The snap hooks shall be of double locking type and shall be designed for single hand operation. The splices shall be protected with a sleeve. The shock absorbing lanyards shall confirm to European Standard EN 355 of CE

7.27.5 Full Body Safety Harness Medium & Large Size:

Adjustable Full Body Safety Harness consisting of shoulder straps, thigh strap, waist belt, fittings, buckles to support the full body of the wearer during fall and after the arrest of the fall. The Harness should be made from tested woven nylon web. The Shoulder and leg strap should be colour distinguished for easier donning. The hard wares should feature anti-corrosion coating. The splices should be lock stitched with nylon threat of contrasting colour for easy inspection. Each Harness should be tagged as per ANSI/ASTM requirements with labels. Tower climbing and suspension harness should have leather lining on the waist and seat strap with back pad of min 120mm wide and with back and shoulders D rings.

7.27.6 Hand Operated Ratchet Hoist - 1.0 Ton:

Hand operated, Unit & Handle made from heat treated aluminum alloy, Compact Design, hardened load sheave & steel load chain, forged steel hooks with safety latches and swivel up to 360 degree. The product should confirm to ASME-B-30.21

Safe Working Load - 1.0 Tones
Ultimate Load - 3 Times the SWL
Max. Weight - 8 Kgs

7.27.7 Hand Operated Ratchet Hoist - 1.5 Ton:

Hand operated, Unit & Handle made from heat treated aluminum alloy, Compact Design, hardened load sheave & steel load chain, forged steel hooks with safety latches and swivel up to 360 degree. The product should confirm to ASME-B-30.21

Safe Working Load	- 1.5 Tones
Ultimate Load	- 3 Times the SWL
Max. Weight	- 12 Kgs

7.27.8 Hand Operated Ratchet Hoist - 2.0 Ton:

Hand operated, Unit & Handle made from heat treated aluminum alloy, Compact Design, hardened load sheave & steel load chain, forged steel hooks with safety latches and swivel unto 360 degree. The product should confirm to ASME-B-30.21

Safe Working Load	- 2 Tones
Ultimate Load	- 3 Times the SWL
Max. Weight	- 14 Kgs

7.27.9 Hand Operated Ratchet Hoist - 3.0 Ton:

Hand operated, Unit & Handle made from heat treated aluminum alloy, Compact Design, hardened load sheave & steel load chain, forged steel hooks with safety latches and swivel up to 360 degree. The product should confirm to ASME-B-30.21

Safe Working Load	- 3 Tones
Ultimate Load	- 3 Times the SWL
Max. Weight	- 16 Kgs

7.27.10. Double Ply Polyester webbing slings - 24mm width:

Double Ply. Polyester webbing slings (Endless) manufactured as per BS EN-1492-1-2000 / ASME B 30.9

Width	- 24 mm
Factor of safety	- 1:5(Minimum)
Effective Length	- 900mm/1800mm
Safe Working Load	- 2000 Kgs in Basket

7.27.11. Double Ply Polyester webbing slings - 45mm width:

Double Ply. Polyester webbing slings (Endless) manufactured as per BS EN-1492-1-2000 / ASME B 30.9

Width	- 45mm
Factor of safety	- 1:5(Minimum)
Effective Length	- 900mm/1800mm
Safe Working Load	- 3000Kgs in Basket

7.27.12. Tarpaulin:

3600mm x 3600mm size Tarpaulin to be used during HLM works

7.27.13. D-shackle/Anchor Shackle:

Forged alloy steel, screw pin, wide body anchor shackles with min UTS 2.0 times the safe working load and hot dip galvanized. The product should confirm to ISO 2415 / BS-EN-13889 / ASME B 30.26

1 Ton Capacity, 10mm size, with max weight of 0.16 KG
3 Ton Capacity, 12mm size, with max weight of 0.35 KG
5 Ton Capacity, 16mm size, with max weight of 0.70 KG

7.27.14. Conductor cart/Spacer Cycle:

Light weight Inspection Conductor Car Suitable for single line man in twin moose/quad conductor of standard spacing, with Nylon rollers mounted on ball bearings complete with nylon straps, stationary brake and counter - Meter device mechanisms. The product should confirm to ASME-B-30.19 and factor of safety of 1:4

Max Over all weight - 20 - 25 Kgs
Pay load capacity - 140 - 150 Kgs

7.27.15 Hand Line Hook:

Hand line hook shall be suitable for a working load of 240 Kg and for attaching at any place along the hand line. The hook shall be made up of forged steel and electro galvanized.

7.28 Insulated Modular Scaffold:

Light weight Insulated Modular Scaffold system of 15 meters height to facilitate live line working in energized substations up to 400 KV AC. Each set of Scaffold system assembly consist of Required support modules & cross pieces made from Expoxiglass , metallic brackets and diagonals suitable to assemble a insulated platform of 2 x 1 meter on top. The scaffold should be supplied with required rails and wheels, guying ropes of minimum 220 meter length and required insulated sticks for staying purpose and all other support tools/ hard wares/ sticks required for successful use of 15M Modular Scaffold Systems in energized substations.

7.29 Tower Mounting Bracket

It's a saddle for tower bracket.

7.30 Line man Tool Bucket

To carry the hot men accessories like suit, gloves etc.

7.30 **Quantities of Equipment &Tools required for one Set**

7.30.1 For the convenience of the Bidder(s) to participate in bidding process, a list of equipment has been indicated in BOQ placed at Annexure-

7.30.2 However, the Bidder(s) may offer additional/equivalent equipment but he should ensure that all the Live Line Maintenance/operation described under Clause No. 1.1 of technical specification shall be accomplished smoothly with the set of tools

offered by him. The Bidder(s) shall furnish along with the bid the supporting logic and documents to establish the same.

7.30.3 If, in the opinion of the Purchaser, certain additional tools are to be included in the list of tools suggested by the Bidder(s) for smooth operation of live line work as indicated in clause 1.1 of this specification, then the Bidder(s) shall supply the same without any extra cost.

7.30.4 In case of tools offered by the Bidder(s) is found to be inadequate to accomplish all the operations detailed under Clause No. 1.1 of Technical specification, the bid shall be considered as incomplete and shall not be considered for further evaluation.

Annexure…..

Bill of Quantities for Transmission Line Live Line Maintenance Works. (Minimum requirement)

Item No.	Particulars	Quantity per Set
1	Spliced Adjustable Strain Carrier Assembly with cold & hot end plates for changing suspension/Tension/"V" suspension insulator strings – complete including strain jack, Trunion, Reversible Ratchet wrench and steel pins etc.	2 set
2	EHV Trough-Design Insulator Cradle Assembly	1 set
3	EHV side opening cradle	2 set
4	Swivel Boom Assembly including bases, mast and side poles	1 set
5	Spliced Heavy Duty Hook Ladders Assembly(Top, Middle and Bottom section)	1 set
6	Attachment for Ladder Assembly includes required swivel sticks- 8 Nos, Spreader Bar-2 Nos, Ladder clamp- 5nos, Double Clamp- 2nos, vertical and Horizontal ladder bases each one.	One set
7	Platform Ladders	One No.
8	Universal Pole of minimum length of 3.0M, 3.6M and 4.2 Meter	One each
9	Insulated Wire Tongs/ Spliced Wire Tongs of minimum length of 3.6M and 4.8M including wire tong bands	4 Nos Each
10	Insulated Strain Link Stick of minimum length 3.0M -1 No and 3.6M- 2nos	Total Three
11	Insulated Swivel Stick of minimum length 2.4M, 3.0M and 3.5M	Two Each
12	Trolley Pole Suspension Insulator Tool	One
13	Insulated Static Ground	Four Nos.
14	Insulated Telescopic Hot Stick:	Two

15	All Angle Cog wrench	Two Nos.
16	Hotline tool trailer	One
17	Universal Tool Kit consist of Pin Holder, Cutout Tool Ratchet Wrench, Cotter Key Remover, Locating Pin, Ball Socket Adjuster, Screw Driver, Clear Vision Mirror, Shepherd Hook, Wrench Head, Insulator Fork, spiral Disconnect, Cotter Key Tool, Universal adopter, Ball socket cotter key remover, Clevis Pin Installer, Knocker, Ball Scoket adjuster and All angle Plier	One set
18	Capstan Hoist	One set
19	Tower Type Wire Tong Saddle Tower Type Saddle with Extensions	7 Nos. 3 Nos.
20	Pole Clamps	6 nos.
21	Nylon Rope Blocks with 45 Meter long, 12mm Composite Fiber Braided Rope	4 nos.
22	Tool Hanger & Clamp	20 Nos.
23	Live Line Tools Racks	4 Pairs
24	Grip-all clamp stick assist ring	4 Nos.
25	Swivel Hook Ladder	1 No.
26	Ratchet wrench including Hex Socket sets	2 set
27	Tool Bucket	8 Nos.
28	Composite Fiber Braided rope of 180 Meter length: i) 10mm ii) 12mm iii) 20mm	 1 No. 2 Nos. 2 Nos.
29	Poly Dacron Rope – 16mm	360 Meters
30	Polypropylene Rope – 12mm	180 Meter
31	Conductive Suits – Medium/Large/Extra Large (set of Pant and shirt)	9 set
32	Conductive Gloves	20 Pairs
33	Conductive Socks	20 Pairs
34	Conductive Boots i) Size 8 ii) Size 9 iii) Size10	 6 Pairs 10 Pairs 8 Pairs
35	Static Belt	4 Nos.
36	Hot Stick Tester	1 No
37	Hot Clamp	4 Nos.
38	Ladder Monitor Kit	1 No

39	Epoxiglass Cleaning Kit	2 set
40	Dry Film Lubricant	2 Nos.
41	Snatch Block With Forged Steel Hook	3 Nos.
42	Snatch Block With Forged meat Hook	6 Nos.
43	Snatch Block of 1000Kg Capacity:	5 Nos.
44	Fall Arrester	12 Nos.
45	Full Body Harness(Medium and Large sizes)	6 Nos. Each
46	Hand Operated Ratchet Hoist- 1.0 Ton	3 Nos.
47	Hand Operated Ratchet Hoist – 1.5 Ton	4 Nos.
48	Hand Operated Ratchet Hoist – 2.0 Ton	2 Nos.
49	Hand O/perated Ratchet Hoist – 3.0 Ton	1 No.
50	Double Ply Polyester webbing slings – 24mm,900mm and 1800 mm length	Each 6 nos.
51	Double Ply Polyester webbing slings – 45mm, 900mm and 1800mm	Each 6 Nos.
52	Tarpaulin - 3600mm x 3600mm	2 Nos.
53	D-Shackle/ Anchor Shackle 1T, 3T and 5 T capacity	18 Nos Each
54	Conductor cart/Spacer Cycle	1 No
55	Hand Line Hook	4 Nos.
56	Insulated Modular Scaffold	1 set
57	Tower Mounting Bracket	1 No
58	Line Man Tool Bag	4 Nos.

Chapter - 8

STRINGING AND MISCELLANEOUS WORKS

9.1 Conductors Stringing

At least **one (1)** months before conductor stringing commences, the Contractor shall submit to the Employer a detailed account of his proposed stringing procedure which should include details of temporary support stays and compensation for initial stretch and long term creep of the conductors.

Full use shall be made of maximum conductor lengths in order to reduce the number of mid span joints to a minimum. After completion of check survey, Contractors has to design the conductor length per drum in such a way, that conductor stringing should be made one tension tower to another, minimizing the joints.

There shall not be more than one joint per conductor in any one span, and tension joints shall not be less than 15 meters from any conductor clamp. No tension joints shall be used:

a) In section of less than 3 spans between tension supports.

b) In spans over navigable rivers, buildings, power lines, telecommunication lines, public roads and in any span subject to special way leave conditions or in any adjacent span.

Conductor repair sleeves shall not be used without the permission of the Employer or Employer's representative.

The conductors, joints and clamps shall be erected using the approved tools and in such a manner that no bird caging, over tensioning of individual wires or layers or other deformation or damage to the conductors occurs. Clamps or other devices used in erection shall be of approved design and shall allow no relative movement of strands or layers of the conductors.

The Contractor shall keep a record of all conductor joints giving the location, the date of assembly and the name of the lineman responsible for the jointing. Where records of joints made by a particular lineman show a repeated performance below that required, the Contractor shall cease to employ the lineman on jointing operations and shall immediately replace him with other qualified personnel.

Phase conductors shall be erected with such sags that everyday temperature in still air and 32 degree C temperature with maximum wind pressure, the final tensions shall provide factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for each type of conductor. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0^{0} C, 20^{0}C, 32^{0}C, 40^{0}C, 60^{0}C, 80^{0}C,…… in still air conditions, and shall show details of conductor size, conductor breaking load, and conditions of loading.

In calculating the sags and tensions, allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

The term "final tension" shall mean the tension existing in a line conductor, for any given condition of loading after sufficient period in service to allow for "bedding down" stretch and creep to take place. For purposes of calculating creep allowance this shall be taken as ten years from erection.

The "equivalent span" method shall be used, in which the tension in any section length is that which would apply to a single span equal to the square root of the length arrived at by dividing the sum of the cubes of the individual span lengths, in the section considered, by their sum. The calculated tensions at the time of initial erection shall be increased by an approved amount to allow for settling of the conductors, other means may be adopted subject to the approval of the Employer or Employer's representative.

At the end of the guarantee period the specified ground clearance plus the conductor creepage allowance shall not be infringed, in addition, the sag of any phase conductors in the same span.

Where required by the Employer, prior to the issue of the Operational Acceptance Certificate, the Contractor shall be responsible for checking that the relative sags of the conductors are within the specified tolerance. Such checks shall be carried out at selected point along the route as required by the Employer. Clearances between conductors and ground and between jumpers and structures shall be checked by the Contractor during erection and before handing over the line.

The Contractor shall provide dynamometers, sighting boards and levels suitably mounted for clamping to support steelworks and other approved apparatus necessary for the proper checking of the work. When required by the Employer, dynamometers shall be tested and if necessary recalibrate at the Contractor's expense.

During the progress of the work, the Contractor shall record on approved schedules the particulars of the sagging of conductors on each section of the route. These schedules shall show the support numbers of the section, individual span lengths, the equivalent span, the design and erection sags, together with the mean actual sag of the phase conductor as well as the temperature, and the dates of the stringing and checking. At the end of the Contract six sets of these schedules shall be handed to the Employer.

Blocks for running out conductors shall be of approved type and shall be robust and full running.

The wheel of the running out block shall have a diameter of not less than 20 times the outside diameter of the conductor and shall be fabricated from aluminum.

The Contractor shall provide as a minimum sufficient running blocks commensurate with stringing the longest section of the project.

Jumper-loops shall be cut to length such that the loop arcs at the points of departure from tension-clamp are naturally tangential to the tension -clamp departure angle.

All conductor, connections and clamps shall be treated with approved jointing grease to prevent galvanic corrosion between dissimilar metals and to inhibit aluminum surface oxidization.

After the line conductors have been finally tensioned to their correct sags, the Contractor shall erect vibration dampers at the recommended distance from the conductor clamps.

The Contractor shall identify the spans where aeronautical signs on the earth wire may need. However instruction from the Employer to put such signs at any span shall be fulfilled without any additional cost to the Employer.

6.3 Shutdown

The Contractor has to carryout dismantling of existing ACSR Bear and ACSR Duck conductor and reconductoring of the same with their equivalent HTLS conductor by following the Hot line stringing procedure (one circuit live and stringing shall be take place in another circuit).

For the stinging work of the lines, the Contractor shall request the Employer for the shutdown of distribution lines, where necessary, at least 7 days in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum, as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown. The Contractor shall complete the work, during the shutdown period within the stipulated time period. If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.

CHAPTER 9: CIVIL WORKS

1.0 GENERAL

The intent of specification covers the following:

Design, engineering, drawing and construction of all civil works at sub-station. All civil works shall also satisfy the general technical requirements specified in other Sections of Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per relevant British standard codes (B S Codes)/ equivalent International Standards.

All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of best quality conforming to relevant International Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail.

The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and direction of NEA/Consultant.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the NEA/Consultant. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

2 SCOPE OF WORK

The work shall include mobilisation of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc.

All the work shall be carried out as per latest edition of the corresponding relevant British standard codes (B S Codes)/ equivalent International Standards. The Agency carrying out the soil investigation work must have the experience of carrying out soil investigation successfully in the relevant field. NEA shall assess the capability of the agency for soil investigation work for which technical inputs may be furnished by consultant to NEA.

3.0 FOUNDATION / RCC CONSTRUCTION

3.1 GENERAL

1. Work covered under this Clause of the Specification comprises the design ,drawing and construction of foundations and other RCC constructions for switchyard tower structures, bus supports, equipment supports, cable trenches, Transformer /Reactors, jacking pad, pulling blocks, fire

protection walls, control cubicles, marshalling kiosks, auxiliary equipments, Control Room Cum Administrative building, GIS hall, Fire fighting Pump house, fire fighting water tanks, Auxiliary Building, Panel room, ,township buildings, Parking shed ,RCC retaining wall, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

2. Concrete shall conform to the requirements mentioned in relevant British standard codes (B S Codes)/ equivalent International Standards. And all the tests shall be conducted as per relevant British standard codes (B S Codes)/ equivalent International Standards. However, a minimum grade of M25 (design Mix) concrete shall be used for all foundations and structural/load bearing members as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3. If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

4. The switchyard foundation's plinths and building plinths shall be minimum 300mm and 500 mm above finished ground level respectively.

5. Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

6. Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

7. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

8. If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of relevant British standard codes (B S Codes)/ equivalent International Standards. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the contractor showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

3.2 DESIGN

While designing foundations, following may be taken care of:

3.2.1. All foundations except for external lighting poles shall be of reinforced cement concrete. The external lighting pole shall be embedded in plain cement concrete (1:2:4) foundation. The design and construction of RCC structures shall be carried out as per relevant BS and minimum grade of concrete shall be M-25 (design Mix). Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the NEA/Consultant.

3.2.2. Limit state method or any other method as per relevant British standard codes (B S Codes)/ equivalent International Standards of design shall be adopted unless specified otherwise in the specification.

3.2.3. For detailing of reinforcement relevant BS followed. Cold twisted deformed bars conforming to relevant British standard codes (B S Codes)/ equivalent International Standards. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3.2.4. RCC water retaining structures like storage tanks, etc. shall be designed as uncracked section in accordance with relevant British standard codes (B S Codes)/ equivalent International Standards. However, water channels shall be designed as cracked section with limited steel stresses as per relevant BS.

3.2.5. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant British standard codes (B S Codes)/ equivalent International Standards of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

3.2.6. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

3.2.7. Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.

3.2.8. RCC columns shall be provided with rigid connection at the base.

3.2.9. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant British standard codes (B S Codes)/ equivalent International Standards or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing

shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

3.2.10. Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

3.2.11. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

3.2.12. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

a) Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).

b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

3.2.13. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

3.2.14. Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

3.2.15. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

3.3 ADMIXTURES & ADDITIVES

3.3.1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be

batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

3.3.2. Admixtures in concrete shall conform to relevant British standard codes (B S Codes)/ equivalent International Standards. The water proofing cement additives shall conform to relevant BS. Concrete Admixtures/ Additives shall be approved by NEA/Consultant.

3.3.3. The Contractor may propose and the NEA/Consultant may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

3.3.4. The water-reducing setting-retarding admixture shall be an approved brand as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3.4 PCC

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

3.4.1 PCC 1:2:4 (1 cement : 2 sand : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer/reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, fencing gate ,external lighting poles etc. as indicated in the approved drawings.

3.4.2 PCC 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations of towers, equipment support structures, buildings, fire fighting water tanks, covered car parking, cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, cable trench crossings, culverts, fence, gate etc. as indicated in the approved drawings.

3.4.3 PCC 1:5:10 (1 Cement: 5 sand: 10 Stone aggregate, 40mm nominal size) shall be provided for site surfacing in switchyard, roof water proofing etc.

All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits etc. shall not be measured and deemed included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

3.5 Steel Reinforcement

Reinforcement steel shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in RCC work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in metric tonnes on the basis of sectional weights as adopted by British Standards/equivalent International standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

3.7 Cable Trenches and Cable trench Crossings

Earthwork, PCC, RCC, reinforcement steel, RCC hume pipes and miscellaneous steel required for construction of Cable Trenches and cable trench crossings shall be measured under respective items of Bid price schedule (BPS) as described in clauses of aforesaid paras. No additional payment for brick work, plaster and PVC pipes used for cable trench crossings and sealing of trench mouth shall be admissible.

4.0 STATUTORY RULES

4.1 Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State). Fire Safety Rules of Tariff Advisory-Committee and Water and sewerage Act for pollution control etc.

4.2 Provisions for fire proof doors, no. of staircases, fire escape stairs ,fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Local Advisory Committee.

4.3 Statutory clearance and norms of Local Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

5.0 FIELD QUALITY PLAN

All tests as required in accordance to BS codes or equivalent International standards have to be carried out. The contractor shall prepare field quality plan for civil works as per relevant /BS codes/equivalent International Standards during detailed engineering stage and submit to NEA/Consultant for approval within ONE month after award of work.

SECTION 10: EHV XLPE POWER CABLE

1 CABLE CONSTRUCTION DETAILS

1.1 The XLPE insulated EHV cable shall conform to the requirements of IEC 60502-2 (applicable clauses only) for construction and IEC 60840/IEC 62067 (as applicable) for testing. The terminating accessories shall conform to IEC 60840/ IEC 62067 (as applicable). The offered cables and its terminating accessories shall be compatible with each other.

1.2 The EHV grade cable shall be single core, unarmoured, stranded, compacted **Aluminium/Copper (as specified in BPS)** conductor, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non-woven tape with water swellable absorbent over insulation screen, followed by radial sealing (Metal sheath of extruded corrugated aluminum), metallic screening by concentric layer of plain copper wire (if required) to meet short time current requirement, followed by an open helix of copper & overall HDPE sheathed & graphite coated and conforming to the technical particulars of specification. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable.

1.3 The cable shall be suitable for laying under the climate conditions (as specified in Section-Project) and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.4 Cable shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

1.5 Progressive sequential marking of the cable length (in metres), at every one metre, shall be provided on the outer sheath of the cable.

1.6 Repaired cables shall not be accepted.

1.7 Allowable tolerance on the overall diameter of the cables shall be $\pm$ 2 mm.

1.8 CONDUCTOR

The conductor shall be of **Copper/Aluminium** wires as specified in the Bid Price Schedule **(BPS)**. The shape of conductor shall be compacted segmental having high compactness and smooth surface finish.

1.9 CONDUCTOR SCREEN

The conductor screen shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.

1.10 INSULATION

The extruded XLPE insulation shall be applied over the conductor screen to the desired thickness in a void free manner.

1.11 INSULATION SCREEN

The insulation screen shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE.

1.12 MOISTURE BARRIER

Longitudinal water barrier:
The longitudinal water barrier shall be applied over insulation screen by a layer of non woven synthetic tape with suitable water swellable absorbent.

Radial Moisture Barrier:
This shall be of extruded corrugated aluminium sheath.

1.13 METALLIC SCREEN:

The metal sheath shall consist of a tube of corrugated aluminium of at least 99.5% purity. The thickness of the corrugated aluminium sheath shall be designed to meet the requirement of the system short circuit rating as specified in **the bidding documents**.

The sheath shall be continuously extruded, of uniform thickness and homogeneous construction, close fitting, seamless and free from defects.

1.14 OUTER SHEATH

The outer sheath shall consist of extruded black coloured HDPE with graphite coating. The outer sheath shall be suitably designed by the addition of chemicals in the outer sheath for protection against termite and rodent attack and shall be coated with graphite.

1.15 RATING

The contractor/ manufacturer shall declare current rating of cable for maximum conductor temperature of 90 degree C under continuous operation and 250 degree C during short-circuit condition. The contractor/ manufacturer shall also declare over load curve with duration for conductor temperature of 105 Deg C. A complete set of calculation made in arriving at the current rating shall be furnished, for laying condition envisaged under the project, during detailed engineering for Employer/Employer's reference.

1.16 CABLE JOINTING ACCESSORIES

4.16.2 The cable jointing accessories shall include all the straight through joints, Cross bonding, earth continuity cables, Link boxes, Sheath Voltage Limiters (SVLs) etc as required for entire cable route. Bidder shall arrange all special tools and tackles required for making these joints at his own cost. **Unless specified separately** in BPS, **cable end terminating kits** shall be deemed included as part of cable jointing accessories.

4.16.3 The straight through joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical conditions as specified in **Section-Project**.

4.16.4 The straight through joints and cable end terminations shall be of proven design and should have been type tested as per relevant IEC. A list of supply of cable jointing accessories which are in successful operation in projects, shall be furnished.

4.16.5 The detailed description on jointing procedure shall be furnished during detailed engineering.

4.16.6 The cable end terminations shall be of anti-fog type and shall be of Polymer type/Porcelain type suitable for withstanding the climatic conditions with required Creepage distance as specified in **bidding documents**. The cable end terminals for terminating the cables shall be complete with accessories & fully compatible with the cables to be supplied. The terminations shall also be capable to withstand mechanical forces during normal and short circuit operations.

4.16.7 The cable end terminations envisaged for **mounting on Transmission Line (T/L) Towers** shall necessarily be of Composite Polymer type to reduce the weight on T/L towers. The cable end terminations envisaged for **GIS interface,** shall comply to IEC 60840. It will be the responsibility of the contractor to ensure smooth interface with GIS equipment.

4.16.8 For termination on the existing equipment, the cable end termination shall be suitable for the existing make of equipment.

2 TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation **(as per bidding documents)** for entire route. The contractor shall submit drawings and arrangements for Employer approval.

3 CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in accordance with acceptable standard practices/statutory requirements.

4 DAMAGE TO PROPERTY

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the Employer. The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

5 TOOLS AND PLANTS

The successful bidder shall arrange, at his own cost, all necessary tools, plant and equipment to carry out the survey and cable installation work. The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

6 BENDING RADIUS

The minimum bending radius of XLPE insulated cables shall be 20XD where “D” means the Outer diameter of the cable.

7 JOINTING AND TERMINATION OF CABLES

The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/ seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriage ways, drive ways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables and water mains should be avoided whenever possible.

Sufficient overlap of cables shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.

The joints of different phases shall be staggered in the jointing bay.

7.1 SUMPHOLES

When jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or baled out by buckets, without causing interference to the jointing operation.

7.2 MEASUREMENT OF INSULATION RESISTANCE

Before jointing, the insulation resistance of both sections of cables shall be checked.

7.3 IDENTIFICATION

The identification of each phase, shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

7.4 MAKING A JOINT

Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

8 CABLE LAYING & TERMINATIONS

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures. The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included:

(i) A sufficient length of spare cable shall be left in the ground, for future needs.
(ii) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
(iii) The cable shall be properly fastened using non-metallic clamps.
(iv) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.
(v) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

(vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.

(vii) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS–3043:1987 (Code of practice for earthing)/ or equivalent International standards.

9 BONDING OF SCREEN/ SHEATH

The screens/sheath shall be cross-bonded under each segment of specified route in accordance with IS-3043 (Code of practice for earthing) or applicable International codes & practices. The bidder shall offer complete cable system in order to limit maximum sheath voltage in accordance with relevant standards and furnish complete set of calculations in support of the same. The screen/sheath shall be connected to the earth stations/ earth pits through disconnecting type link boxes & through Sheath Voltage Limiter (SVL) as required.

All required materials used in the Cross bonding, termination of earth continuity cable, Link box, SVL etc to comply with specification/statutory requirements shall be in the scope of bidder and should be of good quality and compatible with the cable.

10 CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

If the metallic radial water barrier is insulated from the metallic wire screen, a connection suitable to carry the currents occurring during operation must be installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

11 CABLE TERMINATING STRUCTURES

11.1 The terminating structure being supplied, should be designed as per the project requirement for the cable end terminations i.e. for Standalone Outdoor AIS terminations, GIS end terminations and Transmission line Tower end terminations as per requirement specified in BPS.

11.2 The mounting structure shall be fixed on the reinforced cement concrete foundation, the design & drawings of which shall be submitted to Employer for review & acceptance during detailed engineering.

11.3 The mounting structure includes the supports for cable end boxes, link boxes and any other item required for the intent of the contract. All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Employer. The steel for mounting structure shall confirm to IS-2062 (latest).

11.4 In case of cable terminations on transmission line towers, the cable termination kit, LA, Link Box, SVL etc shall be fixed suitably on the tower for which necessary interface details shall be coordinated for Tower design during detailed engineering. After fixing the end terminations, the cable shall be suitably fixed to the tower members, with non-magnetic material clamps to the required height securely. The cable in air shall be suitably protected using HDPE pipes up to certain height.

11.5 In case of GIS end terminations, the structure & foundations shall be suitably designed in coordination with GIS terminations during detailed engineering.

SECTION 11

TECHNICAL DATA SHEET

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.9: 132kV CURRENT TRANSFORMER **Sheet 1 of 1**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
			132kV	**132kV**
1.	**Manufacturer and Country of Origin**			
2.	**Year of manufacturing experience**	Years	5	
3.	**Manufacturing's Designation as per submitted catalogue**			
4.	**Applicable standard**		IEC	
5.	**Type**		Outdoor, Oil immersed	
6.	**Number of phases**	No.	1	
7.	**Number of cores in each CT**	NO.	5	
8.	**Frequency**	Hz	50	
9.	**Rated Primary Voltage**			
9.1	Nominal	kV	132	
9.2	Maximum	kV	145	
10.	**Temperature** rise above 45 degree C ambient at normal rated current	°C		
11.	**Insulation level**			
11.1	Impulse withstand voltage(peak)	kV	650	
11.2.	Power frequency withstand voltage (1min, rms)	kV	275	
12.	**Creepage distance**	mm	3300	
13.	**Short time thermal rating**	kA	25	
14.	**Rated Peak Shortcircuit Current**	kA	62.5	
15.	**Rated VA burden for each core**	VA	30	
16.	**Accuracy class**	5P20 for protection 0.5 for metering PS for diff / Bus		
17.	**Current Ratio** **Core-1, Transformer Diff. Prot. / Distance** **Core-2, Backup Prot.** **Core-3, Metering** **Core-4, 5, Bus Diff. Prot.**	A	As per Technical Data in specification	
18.	**Rated thermal VA burden**	VA	30	
19.	**Overvoltage factor**		1.1	
19a	**Rated continuous thermal current**		1.5x	
20.	Dimension(LXWXH)	mm^3		
21.	Weight	Kg		
22	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
23	Type test certificate submitted?	Yes/No	Yes	
24	Has manufacturer exported units?	Yes/No	Yes	
25	Technical literature / drawings submitted?	Yes/No	Yes	
26.	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		

Deviations from technical requirements:

Signed……. As representative for……

Address…… Date……

ITEM No.6c: 132kV GIS CURRENT TRANSFORMER				
	DESCRIPTION	**UNIT**	**NEA REQ**	**DATA to be Filled**
			132kV	**132kV**
5.	**Type**		Indoor, Metal enclosed	
7.	**Number of cores in each CT**	NO.	5	
9.	**Rated Primary Voltage**			
9.1	Nominal	kV	132	
9.2	Maximum	kV	145	
11.	**Insulation level**			
11.1	Impulse withstand voltage(peak)	kV	650	
11.2.	Power frequency withstand voltage (1min, rms)	kV	275	
13.	**Short time thermal rating**	kA	31.5	
14.	**Rated Peak Short circuit Current**	kA	80	
15.	**Rated VA burden for each core**	VA	30VA	
16.	**Accuracy class**	5P20 for protection 0.2 for metering PS for diff / Bus		
17.	**Current Ratio**	A	As per Technical Data in specification	
19.	**Overvoltage factor**		1.1	
19a	**Rated continuous thermal current**		1.2x	

Technical Data Sheets

Volume – III

Contents

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name & address of Manufacturer		
2.	Construction of conductor/ Designation of conductor as per IEC:1089		
3.1	**PARTICULARS OF RAW MATERIALS**		
3.1	Outer Layers a) Applicable Standard(if any) b) Type of Aluminum alloy c) Minimum purity of aluminum d) Maximum Copper content e) Zirconium content i) Maximum ii) Minimum e) Other elements---------- i) ---------- ii) ----------	 % % % % % %	
3.2	Inner Core a) Applicable Standard(if any) b) Material of core c) Chemical composition of core i) ---------- ii) ----------	 % %	
3.3	Zinc used for galvanization of inner core (if applicable) a) Minimum purity of zinc	 %	
3.4	Chemical Composition of Misch Metal coating on core wires (if applicable) i) Zinc ii) Aluminium iii) Other elements---------- ----------	 % % %	
3.5	Aluminium used for Aluminium Cladding (if applicable) a) Minimum purity of aluminum b) Maximum Copper content c) Other elements---------- i) ---------- ii)……..	 % % % %	

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
4.	**OUTER STRANDS AFTER STRANDING**		
4.1	Number of outer layers	Nos.	
4.2	Number of strands a) 1st Layer from core b) 2nd Layer from core c) 3rd Layer from core …… ……..	 Nos. Nos. Nos. ……. ……..	
4.2	Diameter of strands a) Nominal b) Maximum c) Minimum	 mm mm mm	
4.3	Minimum Breaking load of strand a) Before stranding b) After stranding	 kN kN	
4.4	Resistance of 1m length of strand at 20 deg. C	Ohm	
4.5	Final Modulus of elasticity	Kg/sq. mm	
4.6	Final Coefficient of linear expansion	Per ^{0} C	
5	**INNER CORE STRANDS/ INNER CORE AFTER STRANDING**		
5.1	Number of layers in inner core (excluding central wire)		
5.2	Number of strands a) 1st Layer from centre (excluding central wire) b) 2nd Layer from centre c) 3rd Layer from centre …… ……..	 Nos. Nos. Nos. ……. ……..	
5.3	Diameter a) Nominal b) Maximum c) Minimum	 mm mm mm	
5.3	Minimum Breaking load of strand/Core a) Before stranding b) After stranding	 kN kN	
5.4	Resistance of 1m length of strand at 20 deg. C	Ohm	
5.5	Final Modulus of elasticity	Kg/sq. mm	
5.6	Final coefficient of linear expansion	Per ^{0} C	

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder	
5.7	**Aluminum cladding of INVAR core (if applicable)**			
	a) Thickness of cladding			
	i) Maximum	mm		
	ii) Minimum	mm		
	b)Minimum no. of twists in a guage length equal to 100 times diameter of wire which the strands can withstand in the torsion test			
	a)Before stranding	Nos.		
	b)After stranding	Nos.		
	c) Minimum elongation of strand for a gauge length of 250 mm	%		
	d) Resistance of 1m length of strand at 20 deg. C	Ohm		
5.8	**Galvanising/ Misch Metal coating (if applicable)**			
	a) Minimum mass of zinc coating per sqm. of uncoated wire surface.	gm		
	b) Minimum mass of Misch metal coating per sqm. of uncoated wire surface (if applicable).	Nos.		
	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.	Nos.		
	d) Minimum elongation of strand for a gauge length of 250 mm	%		
6	**FILLER (if applicable)**			
6.1	Type & Designation of Filler			
6.2	Chemical composition of Filler			
6.3	Mass of Filler	Kg/km		
7	**COMPLETE HTLS CONDUCTOR**			
7.1	Cross section drawing of the offered conductor enclosed	Yes/No		
7.2	Diameter of conductor a)Nominal b)Maximum c) Minimum	 mm mm mm		
7.3	UTS (minimum) of Conductor	kN		
7.4	Lay ratio of conductor a) 1st layer from centre (excluding central wire) b) 2nd Layer c) 3rd Layer d)4th Layer		Maximum 	Minimum
7.5	DC resistance of conductor at 20°C	Ohm/km		

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
7.6	Final Modulus of elasticity		
	a) Upto transition temperature	Kg/sq. mm	
	b) Above transition temperature	Kg/sq. mm	
7.7	Coefficient of linear expansion		
	a) Upto transition temperature	Per deg C	
	b) Above transition temperature	Per deg C	
7.8	Calculation for transition temperature enclosed	Yes/No	
7.9	Transition temperature (corresponding to 400 m ruling span and tension at ruling condition as per 6.19)	Deg C	
7.10	Minimum Corona Extinction Voltage (line to ground) under Dry condition	kV(rms)	
7.11	RIV at 1MHz and 305 kV (rms) under dry conditions	Micro-volts	
7.12	Maximum permissible conductor temperature for continuous operation	Deg C	
7.13	Maximum permissible conductor temperature for short term operation	Deg C	
7.14	Permissible duration of above short term operation	Minutes	
7.15	Steady state conductor temperature at conductor current of 1574 A and under Ambient conditions detailed in Clause 1.2.1 of Section-II of the Technical Specification (Vol-II)		
7.16	AC resistance at maximum continuous operating temperature corresponding to specified maximum operating current (1574 A under ambient condition enclosed as per Clause 1.2.1 of Section-II of the Technical Specification)	Ohm/km	
7.17	AC resistance at continuous operating temperature corresponding to specified operating current of 577 A (under ambient condition enclosed as per Clause 1.2.1 of Section-II of the Technical Specification)	Ohm/km	

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
7.18	Details of Creep characteristic for HTLS conductor enclosed (as per Clause 1.4.3 of Section-II of the Technical Specification (Vol-II))	Yes/No	
7.19	**Sag Tension Calculation**		
7.19.1	Sag Tension Calculation enclosed (clause 1.4.1 of Sec-II of TS)	Yes/No	
7.19.2	Tension at 32 deg. C & no wind	Kg	
7.19.3	Sag & tension at maximum continuous operating temperature (corresponding to current of 1574 A and Ambient conditions detailed in Clause 1.4.1 of Section-II of the Technical Specification (Vol-II))	Meters & Kgs	
i)	Tension at 32 deg. C & full wind for following wind pressure :		
a.	Wind Pressure : 218.6 kg/m2	kg	
b.	Wind Pressure : 203.2kg/m2	kg	
c.	Wind Pressure : 161 kg/m2	kg	
7.19.4	Tension at transition temperature	kg	
7.20	Direction of lay for outside layer		
7.21	Linear mass of the Conductor a) Standard b) Minimum c) Maximum	 Kg/km Kg/km Kg/km	
7.22	Standard length of conductor	M	
7.23	Maximum length of conductor that can be offered as single length	M	
7.24	Tolerance on standard length of conductor	%	
7.25	Drum is as per specification	Yes/No	
7.26	No. of cold pressure butt welding equipment available at works	Nos.	

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

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name & address of Manufacturer		……
2.	Address of Manufacturer		……
3.	Drawing enclosed	Yes/No	
4.	Maximum magnetic power loss of suspension clamp at sub-conductor current of 1574 amperes	Watt	……..
5.	Slipping strength of suspension assembly (c!amp torque Vs slip curve shall be enclosed)	kN	……..
6.	**Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension assembly**		
	a) No. of rods per set	No.	……
	b) Direction of lay		……
	c) Overall length after fitting on conductor	mm	……
	d) Actual length of each rod along its helix	mm	……
	e) Diameter of each rod	mm	……
	f) Tolerance in		
	i) Diameter of each rod	±mm	……
	ii) Length of each rod	±mm	……
	iii) Difference of length between the longest and shortest rod in a set	±mm	……

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

Sl.	Description	Unit	Value guaranteed by the Bidder
	g) Type of Aluminium alloy used for manufacture of PA rod set		……
	h) UTS of each rod	Kg/mm²	……
7.	**Particulars of Elastomer (For AGS Clamp only)**		
	a) Supplier of elastomer		……
	b) Type of elastomer		……
	c) Shore hardness of elastomer		……
	d) Temperature range for which elastomer is designed		……
	e) Moulded on insert		Yes/No
8.	UTS of suspension clamp		Yes/No
9.	Purity of Zinc used for galvanising	%	……
11.	Minimum corona extinction voltage under dry condition	kV (rms)	
12.	Radio interference voltage at 1 Mhz for phase to earth voltage of 305 kV (dry condition)		
13.	Maximum permissible continuous operating temperature of		
	i) Clamp body		
	ii) Standard/AGS preformed rods		

Date:
Place:

(Signature)……
(Printed Name)…….
(Designation)…….
(Common Seal)…….

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		.....	
2.	Address of Manufacturer		……..	
3.	Drawing enclosed		Yes/ No	
4.	Purity of aluminum used for aluminum sleeve	%	……	
5.	**Material for steel sleeve**			
	(i) Type of material with chemical composition		……	
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From …….to ……..	
	(iii) Weight of zinc coating	gm/m^2	……	
			Aluminium/ Alloy	Steel
6.	**Outside** diameter of sleeve **before** compression	mm	……..	……..
7.	**Inside** diameter of sleeve **before** compression	mm	……..	……..
8.	Length of sleeve before compression		……..	……..
9.	Dimensions of sleeve **after** compression			
	(a) Corner to Corner		……	……..
	(b) Surface to Surface		……..	…….
10.	Length of sleeve **after** compression		…….	……..
11.	**Weight of sleeve**			
	(a) Aluminium/ aluminum Alloy	kg	……	
	(b) Steel	kg	……	
	(c) Total	kg	……	

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS

Sl.	Description	Unit	Value guaranteed by the Bidder
12.	Electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	……..
13.	Slip strength of dead end assembly	kN	……..
14.	UTS of dead end asembly	kN	……..
10.	Purity of Zinc used for galvanising	%	……..
12.	Design calculation of yoke plates and sag adjustment plate enclosed.		Yes/ No
13.	Minimum corona extinction voltage under dry condition	kV (rms)	
14.	Radio interference voltage at 1 Mhz for phase to earth voltage of 305 kV (dry condition)		
15.	Maximum permissible continuous operating temperature of dead end assembly		

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

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		……	
2.	Address of Manufacturer			
3.	Drawing enclosed		Yes/No	
4.	Suitable for conductor size	mm	……	
5.	Purity of aluminium used for aluminium sleeve	%	……	
6.	**Material for steel sleeve**			
	(i) Type of material with chemical composition		……	
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From …….to ……..	
	(iii) Weight of zinc coating	gm/m^2	……	
			Aluminium/ alloy	Steel
7.	**Outside** diameter of sleeve **before** compression	mm	……..	……..
8.	**Inside** diameter of sleeve **before** compression	mm	……..	……..
9.	Length of sleeve before compression		……..	……..
10.	Dimensions of sleeve **after** compression			
	(a) Corner to Corner		……	……..
	(b) Surface to Surface		……..	…….
11.	Length of sleeve **after** compression		…….	……..

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
12.	**Weight of sleeve**		
	(a) Aluminium	kg	……
	(b) Steel	kg	……
	(c) Total	kg	……
13.	Slip strength	kN	……
14.	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	……
15.	Minimum Corona extinction voltage under dry condition	kV (rms)	……
16.	Radio interference voltage at 1 MHz for phase to earth voltage of 305 kV under dry condition	Microvolt	……
17.	Maximum permissible continuous operating temperature of mid span compression joint	Deg. C	

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

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		……
2.	Address of Manufacturer		
3.	Drawing enclosed		Y es/No
4.	Suitable for conductor size	mm	……
5.	Purity of Aluminium / Al Alloy type	%	……
6.	Dimension of sleeve before compression		
	i) Inside diameter of sleeve	mm	……
	ii) Outside dimensions of sleeve	mm	……
	iii) Length of sleeve	mm	……
7.	Dimension of sleeve after compression		
	i) Corner to Corner	mm	……
	ii) Surface to Surface	mm	…….. ……
	iii) Length of sleeve	mm	
8.	Weight of sleeve	Kg	……
9.	Minimum Corona extinction voltage under dry condition	kV (rms)	……
10.	Radio interference voltage at 1 MHz for phase to earth voltage of 305 kV dry condition)	μV	……
11.	Maximum permissible continuous operating temperature of Repair Sleeve	Deg. C	

NOTE: Tolerances, wherever applicable, shall also be specified.

Date:
Place:

(Signature)……
(Printed Name)…….
(Designation)…….
(Common Seal)…….

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		……	
2.	Address of Manufacturer			
3	**Drawing enclosed**			
	(a) Design Drawing		YES / NO	
	(b) Placement Chart		YES / NO	
4.	Suitable for conductor size	mm	……	
5.	Total weight of one damper	kg		
			Right	Left
6.	Diameter of each damper mass	mm	……	…….
7.	Length of each damper mass	mm	…….	……
8.	Weight of each damper mass	kg	…….	……
9.	Material of damper masses		……	
10.	Material of clamp		……	
11.	Material of the stranded messenger cable		……	
12.	Number of strands in stranded messenger cable		……	
13.	Lay ratio of stranded messenger cable		……	
14.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	……	
15.	Slip strength of stranded messenger cable (mass pull off)	kN	……	

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder	
			Right	Left
16.	Resonance frequencies			
	(a) First frequency	Hz	……	…….
	(b) Second frequency	Hz	……	…….
17	Designed clamping torque	Kg-m		……
18.	Slipping strength of damper clamp			
	(a) Before fatigue test	kN		……
	(b) After fatigue test	kN		……
19.	Magnetic power loss per vibration damper watts for 600 amps, 50 Hz Alternating Current	watts		……
20.	Minimum corona Extinction voltage kV (rms) under dry condition	kV		……
21.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	μV		……
22.	Maximum permissible continuous operating temperature of Vibration Damper	Deg. C		
23.	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%		……
24.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%		……

NOTE: Tolerances, wherever applicable, shall also be specified.

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

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF BUNDLE SPACER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		……..
2.	Address of Manufacturer		
3.	**Drawing enclosed**		
	(a) Design Drawing		YES / NO
	(b) Placement Chart		YES / NO
4	Suitable for conductor size	mm	……..

5. Material / Manufacturing process of component parts

	Material	Manufacturing Process
(a) Insert	……..	……..
(b) Main body	……..	……..
(c) Retaining rods (if any)	……..	……..

6.	**Retaining rods (if used)**		
	(a) Type of alloy used		……..
	(b) Number of retaining rods used for each spacer	no.	……..
	(c) Diameter	mm	……..
	(d) Length	mm	……..
	(e) Weight	kg	……..

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF BUNDLE SPACER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder	
7.	**Elastomer**			
	(a) Contractor		……..	
	(b) Type		……..	
	(c) Moulded on insert		……..	
	(d) Shore hardness		……..	
	(e) Thickness on insert	mm	……..	
	(f) Temp. range for which designed	°C	……..	
8.	**Minimum ultimate tensile strength of spacer**			
	(a) Compressive load	kN	……..	
	(b) Tensile load	kN	……..	
9.	Weight of Spacer	kg	……..	
10.	Designed clamping torque(if applicable)	kg.m	……..	
			Before Vibration	After Vibration
11.	Slipping strength of spacer clamp	kN	……	……
12.	Magnetic power loss per spacer for 1574 Amps, 50 Hz Alternating Current	Watts	……..	
			Maximum	Minimum
13.	Electrical resistance of elastomer cushioned spacer	ohm	…….	…….
14.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	……..	
15.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	μV	……..	
16.	Maximum permissible continuous operating temperature of Bundle spacer	Deg. C	……..	

NOTE: Tolerances, wherever applicable, shall also be specified.

Date: (Signature)……

Place: (Printed Name)…….

(Designation)…….

(Common Seal)…….

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF RIGID SPACER FOR JUMPER FOR HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		……..
2.	Address of Manufacturer		
3.	Drawing enclosed		
	(a) Design Drawing		YES / NO
	(b) Placement Chart		YES / NO
4	Suitable for conductor size	mm	……..
5.	**Material of component parts**		
	(a) Clamp		……..
	(b) Main body		……..
6.	**Manufacturing process for**		
	(a) Clamp		……..
	(b) Main body		……..
	(e) Weight	kg	……..
7.	**Elastomer**		
	(a) Contractor		……..
	(b) Type		……..
	(c) Moulded on insert		……..
	(d) Shore hardness		……..
	(e) Thickness on insert	mm	……..
	(f) Temp. range for which designed	°C	……..

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF RIGID SPACER FOR JUMPER FOR HTLS CONDUCTOR

Sl.	Description	Unit	Value guaranteed by the Bidder	
8.	Minimum ultimate tensile strength of spacer			
	(a) Compressive load	kN	……..	
	(b) Tensile load	kN	……..	
9.	Weight of Spacer	kg	……..	
10.	Designed clamping torque(if applicable)	kg.m	……..	
11.	Slipping strength of spacer clamp	kN	……..	
12.	Magnetic power loss per spacer for Watts 1574 Amps, 50 Hz Alternating Current	watt	……..	
			Maximum	Minimum
12.	Electrical resistance of elastomer cushioned spacer	ohm	……	……
13.	Minimum corona Extinction voltage kV (rms) under dry condition	kV (rms)	……..	
14.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	μV	……..	
15.	Maximum permissible continuous operating temperature of rigid spacer	Deg. C	……..	

NOTE: Tolerances, wherever applicable, shall also be specified.

Date: (Signature)……

Place: (Printed Name)…….

(Designation)…….

(Common Seal)…….

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF SPACER DAMPER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		……..
2.	Address of Manufacturer		
3.	Drawing enclosed		
	(a) Design Drawing		YES / NO
	(b) Placement Chart		YES / NO
4	Suitable for conductor size	mm	……..
5.	**Material of component parts**		
	(a) Clamp		……..
	(b) Main body		……..
6.	Type of Clamps		……..
7.	Type of Damping element		……..
8.	**Manufacturing process for**		
	(a) Clamp		……..
	(b) Main body		……..
	(e) Weight	kg	……..
9.	**Elastomer**		
	(a) Contractor		……..
	(b) Type		……..
	(c) Moulded on insert		……..
	(d) Shore hardness		……..
	(e) Thickness on insert	mm	……..
	(f) Temp. range for which designed	°C	……..

Bidder's Name……..
Specification No……

GUARANTEED TECHNICAL PARTICULARS OF SPACER DAMPER FOR HTLS CONDUCTOR (IF APPLICABLE)

Sl.	Description	Unit	Value guaranteed by the Bidder	
10.	Minimum ultimate tensile strength of spacer			
	(a) Compressive load	kN	……..	
	(b) Tensile load	kN	……..	
11.	Weight of Spacer	kg	……..	
12.	Designed clamping torque(if applicable)	kg.m	……..	
13.	Slipping strength of spacer clamp	kN	……..	
14.	Magnetic power loss per spacer for Watts 1574 Amps, 50 Hz Alternating Current	watt	……..	
			Maximum	Minimum
15.	Electrical resistance of elastomer cushioned spacer	ohm	……	……
16.	Minimum corona Extinction voltage kV (rms) under dry condition	kV (rms)	……..	
17.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	μV	……..	
18.	Maximum permissible continuous operating temperature of spacer damper	Deg. C	……..	

NOTE: Tolerances, wherever applicable, shall also be specified.

Date: (Signature)……

Place: (Printed Name)…….

(Designation)…….

(Common Seal)…….

TECHNICAL DATA FOR 132kV SINGLE CORE 1000 SQMM XLPE INSULATED, ARMOURED CABLE:

Sl. No	**Name of the Particulars**	**Desired Value**	
		1000 sqmm	
1	No. of cores	1(Single)	
2	Size (in mm2)	1000	
3	Voltage Grade(in kV)	76/132(145) kV	
4	Type of cable		
5	Standard according to which cable has been manufactured and tested	IEC- 62067, Testing as per IEC- 60840.	
6	Permissible Voltage & Frequency variation for satisfactory operation.		
	Voltage	$\pm$ 10%	
	Frequency	$\pm$ 5%	
7	Maximum rated conductor temperature	90^0C	
8	Max. allowable conductor temperature during short circuit	250^0C	
9	Conductor Details		
	(a) Normal Cross-Sectional Area	1000 mm^2	
	(b) Material and Grade	Copper as per Specs	
	(c) Shape of Conductor	Compacted stranded circular	
10	**Conductor Screen**		
	(a)Material	Extruded Semi-Conducting XLPE	
	(b)Nominal Thickness	1.5mm(Approx.)	
11	**Insulation**		
	(a) Material	Cross linked Polyethyle	
	(b) Nominal Thickness	18.0 mm	
12	**Insulation Screen**		
	(a) Material	Extruded Semi- Conducting XLPE (SC) layer followed by water swellable SC tapes	
	(b) Min. Thickness	1.0 mm followed by water swellable SC tapes	
	(c) Longitudinal Water Sealing	Semiconducting water blocking tape(s) with 50% over lap	
13	**Metallic Sheath**		
	(a) Material	Seam Welded/ Corrugated Aluminum sheath with anti corrosion protection	
	(b) Thickness	3.0 mm	
	(c) Short Circuit current of metallic screen for 1 sec (kA)	>40	

14	**Outer Sheath**		
	(a) Material	Extruded HDPE	
	(b) Colour	Black	
	(c) Thickness (Nom/Min)	4.0 mm	
	(d) Conducting layer over outer sheath	Graphite Coating	
15	Standard Drum Length with Tolerance	500m±5%	
16	Minimum Bending Radius allowable during installation	20 x OD	
17	Safe Pulling force	5kg/mm^2 of CU area.	
20	(a) Impulse Withstand	650kVp	
21	(b) One minute Power Frequency Withstand Voltage (kV)	190kV for 30 sec	
22	Short circuit current for one second(kA)	143	
	Max conductor DC resistance at 20^{0}C	0.0176 ohm/km	
	Approx. AC resistance at 90^{0}C	0.0233 ohm/km	
	Max. capacitance	0.309 microF/km	
23	Continuous Current Rating for cable laid in close trefoil formation	**BEB/ SPB**	
	(i) In ground at 30^{0}C ground temp, Depth of laying 1.0 m, Thermal Resistivity of soil 150°C Cm/W	655/795	
	(ii) In free air at 40^0 C Ambient Air Temperature	1095/1305	
	BEB: Sheath both end bonded **SPB:** Sheath single point/ Cross bonded		
	1. The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer"s Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. (d) Cable Code i.e. (e) Number of cores & cable size e.g. 1000 Sqmm (Cu) 1 core		

GUARANTEED TECHNICAL PARTICULARS FOR 132 KV CABLE:

Sl. No.	Name of the Particulars		1CX1000 SQMM
1	Type of cable		
2	Standard according to which cable has been manufactured and tested		
3	Rated Voltage (Uo/U}		
4	Highest System Voltage which the cable can withstand		
5	Maximum Conductor temperature for continuous operation		
6	(a) Maximum short time conductor temperature with duration		
	(b) Maximum allowable conductor temp. during overload		
7	Conductor Details		
	Normal Cross-Sectional Area		
	Material and Grade		
	Shape of Conductor		
	Diameter of Conductor		
	No. of Strands and Diameter of each Strand		
	Water swellable powder/yarn provided		
	Conducting water swellable tape with 50% overlap over compacted conductor provided		
8	Extruded Conductor Screen		
	Material		
	Nominal Thickness		
	Diameter over Conductor screen		
	Designed maximum stress at conductor screen		
9	Insulation		
	Material		
	Nominal Thickness		
	Minimum thickness at any point		
	Diameter over insulation		
	Designed maximum stress		
	Detail of vulcanization process		
	Extrusion method		
	Curing method		
	Cooling method		
	CO/ or VOI Line		
10	Extruded Insulation Screen		
	Material		
	Thickness		
	Diameter over insulation screen		
	Strippable/ Bonded		
11	Conducting Longitudinal Water Sealing		
	Material		
	Thickness		
12	Metallic Sheath/ Screen		
	Material		
	No. of strands		
	Diameter of each Strand (Nom/Min)		
	Diameter of Cable after stranding		
	Armour coverage		
13	Non-conducting Longitudinal Water Sealing		
	Material		
	Thickness		
14	HDPE Outer Sheath		
	Type		
	Colour		

	Thickness (Nom/Min)		
	Conductive Coating Provided		
15	Nominal overall Diameter of cable		
16	Nominal OVerall Weight of Cable per Meter		
17	Standard Drum Length with Tolerance		
18	Minimum Bending Radius allowable during installation		
19	Short Circuit Current Rating of Conductor with maximum conductor temperature (90°C) at the commencement of fault 1Sec. Duration		
20	Maximum Continuous Current Rating of a Circuit Comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.		
	Soil Temperature		
	Ambient Temperature		
	Soil Thermal Resistivity		
	System of Bonding		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
21	Short Time Overload capacity (2 hours)		
	Laid in ground (at a depth of 1.05 m)		
	Laid in dusts		
	Installed in Air		
22	Maximum AC Resistance at 90°C		
23	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation		
24	Maximum Charging Current per Conductor		
	at Nominal Voltage 1.64 AI km		
25	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation		
26	Maximum Current in Metallic Screen when the cable is installed (Circulating Current)		
27	Derating factor of Cable installed under following conditions Ambient Temperature		
	35°C		
	45°C		
28	Group derating factor of Cable Circuits installed under following conditions		
	Laid 100 mm. apart		
	Laid 250 mm. apart		
29	Induced voltage in metallic screen when Conductor is carrying 100 Amps(V/Km)		
30	Circulating current in metallic screen when conductor is carrying 100 Amps		
31	Test Voltages		
	Impulse Withstand Voltage at 90°C		
	Rated Power Frequency Withstand Voltage (kV)		
	Water penetration test as per IEC 60840		
	Abrasion Test on HDPE Outer sheath as per IEC 60229		
	Recommended Test Voltage after installation		
32	Details of Drum		
	Material and Weight of Drum		
	Weight of Drum with Cable		
	Flange Diameter of Drum		
	Barrel Width of Drum		
	Spindle hole Diameter		
33	Safe Pulling force		
34	Moisture barrier		
	Material		

	Min. Thickness (in mm)		
35	Metallic sheath		
	Material		
	Type of corrugation		
	Gap (in mm)		
	Min & nom thickness		
	Diameter above metallic sheath		
	Anti Corrosive layer		
	Material		
	Tape		
36	The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre.		
	(a) Manufacturer"s Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 132 kV (d) Cable Code (e) Number of cores & cable size e.g. 630 Sq mm (Cu) 1 core 1000 Sqmm (Cu) 1 core		
	Sequential length marking shall also be provided on outer sheath by inkjet printing.		
	Cable shall be supplied in steel drums		