BIDDING DOCUMENT

FOR

"Turnkey construction of 33kV Feeder Bay along with associated works at 132kV Narengi GSS for power supply to OIL"

FUND: "Deposit Scheme"

(E-Tender)

(VOL – II: Technical Specifications)

BID IDENTIFICATION NO:

AEGCL/MD/Tech-257/Deposit work/33KV OIL/Narengi GSS/2022/Bid

ASSAM ELECTRICITY GRID CORPORATION LIMITED

Rs.1000

Section - 4

Technical Specification

(This Section contains the Technical Requirements and supplementary information that describe the Goods and Related Services)

4.1.0 SCOPE AND GENERAL TECHNICAL CONDITIONS

4.1.1 INTENT OF THE SPECIFICATION

This volume of the specification deals with the general technical information & criteria for design, manufacture and delivery of equipment/material.

The provisions of this section shall supplement all the detailed Technical Specifications and requirements brought out herein. The Supplier's proposal shall be based on the use of materials complying fully with the requirements specified herein.

4.1.1.1 SCOPE

The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site of various equipment and materials including substation steel structures as specified in subsequent Clauses and Sections.

It is not the intent to specify completely herein all details of design and construction of the equipment and accessories. However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the bidder's guarantees in a manner acceptable to the Purchaser. The Purchaser will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance therewith.

The major items of works included in the scope of this specification are listed below: -

i) Design & supply of all substation switchgears, control gears and protection equipment as per this bidding document.
ii) Supply of substation/ equipment mounting steel structure, power cables etc as specified.
iii) Erection, testing and commissioning of all switch & control gears such as circuit breakers, isolators, current transformers, relay & control panels, Lightning Arresters etc. as specified in Bill of Materials.
iv) Extension of 33KV Bus system using XLPE cable
v) Construction of cable trenches and earth mat including supply of all materials
vi) Other works includes site development, construction of equipment and structure foundations, drain, boundary wall, main & wicket gate etc. as brought out in the Specification and Schedule of Requirements.
vii) Integration of all switch & control gears of the bay including control and relay panel along with the ABT metering module into the existing Substation Automation System at Narengi GSS. The integration of the newly supplied CRP to the existing ABB make SAS at 132kV Narengi GSS, AEGCL has to be done by authorized representatives of the OEM only. Also, if the OEM of the supplied C&R Panels is different from the OEM of the existing SAS, then the integration of the supplied C&R Panel with the existing SAS has to be done by the authorized representatives of both the OEM. The arrangement for the integration of the C&R Panel with the existing SAS of AEGCL, as desired, shall be under the contractor's scope.

The various items of supply are described very briefly in the schedule of Bid Form, Prices & Other Schedules and annexure. The various items as defined in these schedules shall be read in conjunction with the corresponding section in the technical specifications including amendments and, additions if any.

The tentative Bill of Quantities is furnished in Section 3: Price Schedules. The BOQ is for indicative purpose only and the bidder is required to fill up the BOQ/price schedule as given in the e-tendering portal.

4.1.2 SUPPLIER TO INFORM HIMSELF FULLY

4.1.2.1 The Supplier should ensure that he has examined the General Conditions, qualifying criteria, Specifications and Schedules as brought out in Volume-1 and this Volume and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.

4.1.2.2 The Purchaser shall not be responsible for any misunderstanding or incorrect information obtained by the Supplier other than information given to the Supplier in writing by the Purchaser

4.1.3 SERVICE CONDITIONS

4.1.3.1 The plant and materials supplied shall be suitable for operation under the following climatic and other conditions:

A)	Peak ambient day temperature in still air	: 45^{O} C
B)	Minimum night temperatures	: 0^{O} C
C)	Reference ambient day temperature	: 45^{O} C
D)	Relative Humidity	
	a) Maximum b) Minimum	:100% : 10%
E)	Altitude	Below 1000M above MSL
F)	Maximum wind Pressure	As per IS: 802 latest code
G)	Other data	Refer meteorological date pertaining to the locations.
H)	Seismic intensity	Zone V as per IS 1893

4.1.4 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS:

4.1.4.1 The Supplier shall note that all substation works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, in regard to the rules and regulations that may be applicable.

4.1.5 STANDARDS

4.1.5.1.1 The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory authorities.

4.1.5.1.2 In case of any conflict between the standards and this specification, this specification shall govern.

4.1.5.1.3 Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance than that specified under Clause 1.6.1 above shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid.

4.1.6 ENGINEERING DATA

4.1.6.1 The furnishing of engineering data by the Supplier shall be in. accordance with the Bidding Document. The review of these data by the Purchaser will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Purchaser shall not be considered by the Supplier, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

4.1.6.2 All engineering data submitted by the Supplier after review by the Purchaser shall or part of the contract document.

4.1.7 DRAWINGS AND DOCUMENTS FOR APPROVAL

4.1.7.1 The supplier shall submit all drawings and documents of all equipment to be supplied, including drawings of foundation, steel structure and any other drawings that may be required for successful completion of the project and get it approved by the Purchaser (AEGCL).

4.1.7.2 In addition, the following sub clauses shall also apply in respect of Contract Drawings.

4.1.7.3 All drawings submitted by the Supplier including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

4.1.7.4 Each drawing submitted by the Supplier shall be clearly marked with the name of the Purchaser, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

4.1.7.5 The drawings submitted for approval to the Purchaser shall be in quadruplicate. One print of such drawings shall be returned to the Supplier by the Purchaser marked "approved/approved with corrections". The Supplier shall there upon furnish the Purchaser additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

4.1.8 INSPECTION & INSPECTION CERTIFICATE

4.1.8.1 The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have, at all reasonable times, access to the premises and works of the Supplier and their sub-Supplier(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

4.1.8.2 All routine and acceptance tests whether at the premises or works of, the Supplier or of any Sub-Supplier, the Supplier except where otherwise specified shall carry out such tests free of charge. Items such 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 in accordance with the Contract shall be provided by the Supplier free of charge.

4.1.8.3 If desired by the Purchaser, the Supplier shall also carry out type tests as per applicable Standards for which Purchaser shall bear the expenses except in cases where such tests have to be carried out in pursuance to ***Clause 1.18.3***. The Supplier is required to quote unit rates of type test charges in a separate Schedule (if such schedule is provided in the Bidding Document) in pursuance to this Clause. However, these type test charges shall not be taken into account in comparing Price Bid.

4.1.8.4 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Supplier in respect of the agreed Quality Assurance Programme forming a part of the Contract.

4.1.8.5 Tests

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

i) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to Commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.

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

iii) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

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

v) The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Supplier and the Purchaser.

4.1.8.6 The standards and norms to which these tests will be carried out are specified in subsequent Sections of this Specification. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified or as mutually agreed to between the Supplier and the Purchaser in the Quality Assurance Programme.

4.1.8.7 For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder or applicable Standards, as applicable.

4.1.9 EMPLOYER'S SUPERVISION

4.1.9.1 To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all matters and questions shall be resolved in accordance with the provisions of this document.

4.1.9.2 The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Employer, pursuant to the contract, will include but not be limited to the following.

(a) Interpretation of all the terms and conditions of these Documents and Specifications.

(b) Review and interpretation of all the Contractors drawings, engineering data etc.

(c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.

(d) Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.

(e) Issue certificate of acceptance and/or progressive payment and final payment certificate.

2.1.10 GUARANTEED TECHNICAL PARTICULARS

2.1.10.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders. The Bidder shall also furnish any other information's as in their opinion is needed to give full description and details to judge the item(s) offered by them.

2.1.10.2 The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (as per the requirement of the specification) required. A Bidder may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum/maximum value required as per the technical specification. No preference what *so* ever shall be given to the bidder offering better/more stringent values than those required as per specification except where stated otherwise.

2.1.11 PACKING

2.1.11.1 All the materials 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. The Supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

2.1.11.2 The Supplier shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.

2.1.11.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

2.1.11.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e. fragile, handle with care, use no hook etc. wherever applicable.

2.1.11.5 Each package shall be legibly marked by the-Supplier at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the Supplier etc.

2.1.12 CONSTRUCTION TOOLS, EQUIPMENTS ETC.

2.1.12.1 The Contractor shall provide all the construction equipment, tools, tackle and scaffoldings required for construction, erection, testing and commissioning of the works covered under the Contract including construction power water supply etc. He shall submit a list of all such materials to the Employer before the commencement of work at site. These tools and tackle shall not be removed from the site without the written permission of the Employer

2.1.13 MATERIALS HANDLING AND STORAGE

2.1.13.1 All the supplies under the Contract as well as Employer supplied items (if any) arriving at site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

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

2.1.13.3 The Contractor shall maintain an accurate and exhaustive record-detailing out the list of all items received by him for the purpose of erection and keep such record open for the inspection of the Employer.

2.1.13.4 All items shall be handled very carefully to prevent any damage or loss. The materials stored shall be properly protected to prevent damage. The materials from the store shall be moved to the actual location at the appropriate time to avoid damage of such materials at Site.

2.1.13.5 All the materials stored in the open or dusty location must be covered with suitable weatherproof and flameproof covering material wherever applicable.

2.1.13.6 The Contractor shall be responsible for making suitable indoor storage facilities, to store all items/materials, which require indoor storage.

2.1.13.7 The Contractor shall have total responsibility for all equipment and materials in his custody, stored, loose, semi-assembled and/or erected by him at site. The contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss.

2.1.13.8 The Employer will verify the storage facilities arranged by the contractor and dispatch clearance will be provided only after Employer is satisfied.

2.1.14 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

2.1.14.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the work under intimation to the Engineer. All such goods shall, from the time of their being brought vest in the Employer, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Engineer. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage there to

2.1.14.2 The Employers shall have a lien on such goods for any sum or sums, which may at any time, be due or owing to him by the Contractor, under in respect of or by reasons of the Contract. After giving a fifteen (15) days' notice in writing of his intention to do so, the Employer shall be at liberty to sell and dispose of any such goods, in such manner, as he shall think fit including public auction or private treaty.

2.1.14.3 After the completion of the Works, the Contractor shall remove from the Site under the direction of the Engineer the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Engineer. If the Contractor fails to remove such materials within fifteen (15) days of issue of a notice by the Engineer, the Engineer shall have the liberty to dispose of such materials as detailed under clause 1.24.2 above and credit the proceeds thereto to the account of the Contractor.

2.1.15 COMMISSIONING SPARES

1.24.1 It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

1.24.2 These spares shall be received and stored by the Contractor at least 3 months prior to the schedule date of commencement of commissioning of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of performance and guarantee test shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer's Representative.

4.2.0 SPECIFICATION FOR DESIGN AND FABRICATION OF SUBSTATION STEEL STRUCTURES

4.2.1 SCOPE

4.2.1.1 This section covers the design parameters and specification for fabrication and galvanising, of steel structures, bolts & nuts, tower accessories etc for Substations covered under this Bid Document.

4.2.2 MATERIALS

4.2.2.1 Structural Steel

The structures shall be of structural steel conforming to any of the grade, as appropriate, of IS 2062 (latest edition) Steel conforming IS 8500 may also be used.

Medium and high strength structural steels with known properties conforming to any other national or international standards may also be used.

4.2.2.2 Bolts

Bolts used shall conform to IS12427 or bolts of property class 4.6 conforming to IS 6639 may also be used.

High strength bolts, if used (only with steel conforming to IS 8500) shall conform to property class 8.8 of IS 3757.

Foundation Bolts shall conform to IS 5624.

Step bolts shall conform to IS 10238

4.2.2.3 Nuts

Nuts shall conform to IS 1363 (Part 3). The mechanical properties shall conform to property class 4 or 5 as the case may be as specified in IS 1367 (Part 6) except that the proof stress for nuts of property class 5 shall be as given in IS 12427.

Nuts to be used with high strength bolts shall conform to IS 6623.

4.2.2.4 Washers

Washers shall conform to IS 2016. Heavy washers shall conform to IS 6610. Spring washers shall conform to type B of IS 3663

Washers to be used with high strength bolts and nuts shall conform to IS 6649.

4.2.2.5 Galvanisation

Structural members, plain and heavy washers shall be galvanized in accordance with the provisions of IS 4759.

Spring washers shall be hot dip galvanized as per service grade 4 of IS 4759 or IS 1537.

4.2.2.6 Other Materials

Other materials used in the construction of the supporting structures shall conform to appropriate Indian Standards wherever available.

4.2.3 DESIGN PARAMETERS

4.2.3.1 Switchyard structures such as columns, beams and equipment mounting structures shall be designed as per actual site requirement. The drawings are to be submitted for approval prior to supply/execution.

Note: Structures with earth peak shall assume to have four earth wires for design purpose in normal condition

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4.2.3.2 **Spans**

Following Spans shall be considered in design of all structures as applicable: -

a). Line gantries (structures to terminate lines):

(i) For 33 KV Switchyard: 50 Meter, wind & weight span.

b). All other Structures

(i) For 33 KV Switchyard: 20 Meter, wind & weight span.

4.2.4 Deviation Angle

The design of line gantries shall only be checked for a maximum deviation angle of 300 from normal at center of gantries to Dead End Tower.

4.2.5 Conductors and Shield Wires

a) The Conductor shall conform to IS: 398 (latest edition) except where otherwise specified herein.

The details of the ACSR Moose, ACSR Zebra and ACSR Panther conductors are tabulated below:

	DESCRIPTION	**ACSR 'MOOSE'**	**ACSR 'ZEBRA'**	**ACSR 'PANTHER'**
1	Code name	MOOSE	ZEBRA	PANTHER
2	Number of strands & size	Al: 54/ 3.53 mm	Al: 54/ 3.18 mm	Al: 30/ 3.00 mm
		St: 7/ 3.53 mm	St: 7/ 3.18 mm	St: 7/ 3.00 mm
3	Overall diameter	35.05 MM	28.62 mm	21.00 mm
4	Breaking load	136.38 KN	130.32 kN	130.32 kN
5	Weight of conductor	2004 Kg/KM	1621 kg / km	974 kg / km
6	Co-efficient Of Linear Expansion	23x10-6 /0C	19.35x10-6 /0C	19.35x10-6 /0C
7	Number of strand			
	Steel centre	1	1	1
	1st Steel Layer	6	6	6
	1st Aluminium Layer	12	12	12
	2nd Aluminium Layer	18	18	18
	3rd Aluminium Layer	24	24	-
8	Sectional area of Aluminium	528.50 mm2	428.90 mm2	212.10 mm2
9	Total sectional area	597.00 mm2	484.50 mm2	261.50 mm2
10	Calculated d.c. resistance at 20 C	0.05552 ohm/km	0.06869 ohm/km	0.1400 ohm/km
11	Ultimate tensile strength	161.2 kN	130.32 kN	89.67

b) For protection against direct lightning G.I. wires of size 7/3.66 mm conforming to IS 2241 shall be considered for all switch yards.

4.2.6 DESIGN DRAWINGS

4.2.6.1 The relevant drawings for all the towers, beams and equipment mounting structures shall be furnished by the Supplier to the Purchaser which shall include structural/fabrication drawings, Bill of Materials including nuts and bolts.

4.2.6.2 The structural drawings, Bill of materials and shop fabrication drawings for all the structures shall be submitted in four copies and will be finally approved by the Purchaser.

The fabrication shall be taken up from the approved shop drawings.

The overall responsibility of fabricating structure members correctly lies with the Supplier only and the Supplier shall ensure that all the members can be fitted while erecting without any undue strain on them.

4.2.7 ACCESSORIES

4.2.7.1 Step Bolts

Each column/tower shall be provided with step bolts conforming to IS: 10238 of not less than 16mm diameter and 175mm long spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN.

4.2.7.2 Insulator Strings and Conductor Clamps Attachments

a) Single suspension and tension insulator string assemblies shall be used for stringing busbars For the attachment of Suspension Insulator string, a suitable strain plate of sufficient thickness for transferring the load to the tower body shall be provided. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the insulator string the same shall be supplied by the Supplier.

b) At tension points strain plates of suitable dimensions placed on the beams, shall be provided for taking the hooks or D-shackles of the tension insulator strings. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Supplier.

4.2.7.3 Earth wire Clamps Attachment

i. **Suspension Clamp**

The detailed drawing shall be submitted by the Supplier for Purchaser's approval. The Supplier shall also supply U-bolts, D-shackles wherever required.

a) **Tension Clamps**

Earth-wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The Supplier shall also supply the U-bolts wherever required and take Purchaser's approval for details of the attachments before the mass fabrication.

4.2.8 FABRICATION

4.2.8.1 The fabrication of substation steel structures shall be in conformity with the following:

a. Except where hereinafter modified, details of fabrication shall conform to IS: 802 (Part-II) or the relevant international standards.

b. The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.

c. No angle member shall have the two leg flanges brought together by closing the angle.

d. The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.

e. The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.

f. All identical parts shall be made strictly inter-changeable. All steel sections before any work are done on them shall be carefully levelled, straightened and made true to detailed drawings by methods which will not injure

the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.

g. Minimum Thickness of Tower Members shall be as follows: -

ITEM	Minimum thickness (in mm)
Leg members & main chords of beams in compression	5
Other members	4

4.2.9 Drilling and Punching

4.2.9.1 Before any cutting work is started, all steel sections shall be carefully strengthened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

4.2.9.2 Holes for bolts shall be' drilled or punched with a jig but drilled holes shall he preferred. The punching may be adopted for thickness up to 16mm. Tolerances regarding punch holes are as follows:

a) Holes must be perfectly circular and no tolerances in this respect are permissible.

b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. I.e. the allowable taper in a punched holes should not exceed 0.8 mm on diameter.

c) Holes must be square with the plates or angles and have their walls parallel.

4.2.9.3 All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

4.2.10 Erection mark

4.2.10.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing.

4.2.11 GALVANIZING AND PAINTING

4.2.11.1 Galvanising of the various members of the structures shall be done only after all works of sawing, shearing, drilling, filling, bending and matching are completed. Galvanising shall be done by the hot dip process as recommended in IS: 2629 or other such authoritative international standards and shall produce a smooth, clean and uniform coating of not less than 61 0 gm per square meter. The preparation for galvanising and the galvanising process itself must not affect adversely the mechanical properties of the treated materials. No manual Galvanization process will be accepted.

4.2.11.2 All assembly bolts shall be thoroughly hot dip galvanised after threading. Threads shall be of a depth sufficient to allow for the galvanized coating, which must not be excessive at the root of the threads, so that the nut shall turn easily on the completed bolts without excessive looseness. The nut threads shall not be galvanised, but oiled only.

4.2.11.3 The outside surface shall be galvanised. Sample of galvanised materials shall be supplied to the galvanised test set out in IS 729 or other such authorative international standards.

4.2.12 EARTHING

4.2.12.1 To keep provision in the structures for earthling, holes shall be drilled on two diagonal opposite legs of the towers/columns/mounting structures. The holes shall be suitable for bolting 65 mm X 1 2 mm GI strips and shall

be such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earthling strip.

4.2.13 TEST AND TEST CERTFICATE

4.2.13.1 Each consignment ready for transportation shall be offered to AEGCL for inspection before dispatch giving a minimum time of not less than 30 days. Samples of fabricated structure materials shall be subjected to following tests: -

a) Steel: The structural steel shall conform to IS 226 and IS 8500, BS 4360-1068 or ISO / R 630 other such authoritative international standards. Manufacturer's test certificate shall be submitted for all used steel.

b) Galvanising: The galvanising shall be as per IS 2633 or BS 729 other such authoritative international standards. Zinc coating over the galvanised surfaces shall not be less than 610 gm per square meter.

c) Bolts and nuts: Manufacturer's test certificate as per standard practice shall be submitted.

4.2.14 TEST AT SUPPLIER'S PREMISES

4.2.14.1 The Supplier shall fabricate one specimen structure of each type as soon as possible after placement of order and before starting the bulk fabrication of the structures ordered. It shall be assembled on a foundation as nearly similar as practicable to site and tested with suitable test loads as per specified broken wire condition, multiplied by the corresponding factor of safety to ensure that the design and fabrication complies with the requirements. Each structure shall be capable of withstanding the above-mentioned tests without any injury or any permanent deflection at any part. If any member is found to be weak or damaged the design should be suitably modified and the tower re-tested.

4.2.14.2 After the first lot of the structures manufactured, the members forming one structure of each type shall be selected at random from the lots of similar member and assembled in exactly the same manner as to be done at site. The structure then shall be set on foundation as nearly similar as practicable to site and tested with equivalent test load for which the structure has been designed.

4.2.14.3 No structure or any member thereof, which failed the test shall be supplied.

4.3.0 TECHNICAL SPECIFICATION OF 132KV, 220KV & 400KV XLPE CABLE AND TERMINATION

4.3.1 SCOPE

(i) The specification covers Design, Engineering, Construction, Supply & Delivery, Erection, Laying, Testing & Commissioning including Transportation & Insurance, Storage of XLPE Cable of different ratings and their associated works.

(ii) The cables shall be erected using perforated cable trays, which shall be fixed with the boundary walls on one end and the other ends shall be supported by mounting structures. The mounting structures shall be constructed at 1 metre interval throughout the cable route. The cables shall be erected in trefoil formation. The erection of mounting structures for cable tray support including construction of foundation and supply of foundation materials shall be quoted along with the erection of cable item in the BoQ

4.3.2 STANDARD & CODES

Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted. Copies of such standards shall be submitted by the bidder along with the bid.

IS 7098 : Part 3 : 1993	Cross-linked polyethylene insulated thermoplastic sheathed cables: For working voltage from 66KV up to and including 220KV.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 1255 : 1983	Code of practice for installation and maintenance of power cables upto and including 33KV rating.
IS 3975 : 1999	Mild steel wires, formed wires and tapes for armouring of cables.
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 6380 : 1984	Elastomeric insulation and sheath of electric cables.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords.
IS10418 : 1982	Drums for electric cables
IS 5 : 1994	Colours for ready mixed paints and enamels.
IS 617 : 1994	Aluminum and aluminium alloy ingots and castings for general engineering purposes (Superseded IS 20: 1977)
IS 3043 : 1987	Code of practice for earthing.
IS 5578 : 1984	Guide for marking of insulated conductors.
IS 11353 : 1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
IS 5216 : Part I : 1982	Recommendations on Safety Procedures and Practices in Electrical Work.

IS 2071 : 1993	High voltage test techniques.
IEC-60540	Power cables with extruded insulation and their accessories and cords
EC 60060 : 1989	High Voltage Test Techniques
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1KV up to 30KV
IEC-60754 : 1991	Tests on gases evolved during combustion of electric cables
IEC-60183 : 1990	Guide to the Selection of High Voltage Cables.
IEC-60230 : 1996	Impulse tests on cables and their accessories.
IEC-60840 / IEC- 62067	Testing
IEC-60287 : 1995	Calculation of the continuous current rating of cables (100%load factor).
IEC-60304 : 1982	Standard colours for insulation for low-frequency cable and wires
IEC-60331 : 1970	Fire resisting characteristics of Electric cables.
IEC-60332 : 1992	Tests on electric cables under fire conditions.
BS-5468	Cross-linked polyethylene insulation of electric cables
IEC-60228 : 1978	Conductors of insulated cables
IEC-60332 : 1993	Test on electric cables under fire conditions
IEC-60066	Environmental Test
IEC-60117	Graphical Symbols
IEC-60270 : 2000	Partial Discharge Measurements
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
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)

4.3.3 COMPLIANCE TO SPECIFICATION & DEVIATION:

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidence. Such deviations suggested may or may not be accepted by the purchaser.

As a mark of technical conformance, all sheets of the specification shall be furnished by each bidder with the signature and company seal affixed thereon. In case of any deviations, the same shall be carried out in the deviation schedule only. Deviations not mentioned in Deviation schedule will not be considered.

The bidder shall also submit the GTP as per Annexure-1 duly signed with date & company seal for acceptance of the Technical Bid unless which the bid may be considered as non-responsive.

4.3.4 CONSTRUCTION

1. **For 132KV and above:** The cable shall be of applicable EHV grade as per requirement according to price schedule, single core, unarmored, stranded compacted circular Copper conductor in case of cross section less than or equals to 800 sq.mm or segmental compacted circular (Miliken) Copper conductor in case of cross section over 800 sq.mm, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, crosslinked 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 of corrugated & seamless or seam welded aluminum with asphalt coating & overall PE sheathed & graphite coated and conforming to the technical particulars of specification.

2. **For 33KV :** Untinned annealed copper of class 2 as per IS 8130/1984 and any latest amendments to it. The shape of conductor shall be compacted, stranded, and circular, shielded with conductor screen of black extruded semi-conducting XLPE compound , XLPE insulation, shielded with insulation screen of black extruded semi-conducting compound, black semi-conducting tape and metallic screen of copper tape, Inner sheath extruded PVC type ST2, single layer of strip/ round steel or round hard drawn aluminium wire armoured as per IS :7098 part II and black extruded FR PVC (TypeST-2) overall sheathed, conforming generally to IS:7098 (PartII).

Cables used earlier or repaired after damaged shall not be accepted. IS 7098 part 3 shall be followed for manufacturing of cable along with technical specification.

3. The construction of cable shall generally conform to the description mentioned above. 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. The bidder shall enclose with the bid, drawing showing cross section of the cable.

4. The cable shall be suitable for laying underground with uncontrolled back fill and chances of flooding by water and suitably designed by the addition of chemicals in the outer sheath to be protected against rodent and termite attack.

5. The cables shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

6. Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of the cable.

7. 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.

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

(Note: IS 7098 part III shall be followed for cable construction.)

4.3.5 COMPOSITIONS OF CABLE CONDUCTOR

The conductor shall consist of annealed copper stranded wires. The compacted circular conductor

shall consist of segments wounded up and then compacted. For the cable sizes having cross section over 800 sq.mm, the segmental compacted circular conductor having minimum four (4) segments should be constructed for the supply under the scope of bid. When the conductor's cross-section is less than 800 sq.mm, the compacted circular is applied generally.

4.3.6 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.

4.3.7 INSULATION

The insulation material shall be extruded cross-linked polyethylene. In order to ensure that the screen and insulation are intimately bonded together and free from all possibilities of voids between layers, the conductor screen, the insulation and the insulation screen should be extruded simultaneously in one process in single cross-head. The extrusion process should be carried out under strictly controlled atmospheric conditions.

The thickness of the insulation layer should be maintained as the maximum value figured out from the design of the impulse voltage and A.C. voltage. The cross-linking process by N2 gas should be preferred instead of conventional cross-linking process by saturated steam.

4.3.8 INSULATION SCREEN

The insulation screen shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE.

4.3.9 MOISTURE BARRIER

The longitudinal water barrier shall be applied over insulation screen by a layer of non-woven synthetic tape with suitable water swellable absorbent.

4.3.10 METALLIC SCREEN:

The metallic screen shall be of Lead Alloy 'E" as per IS 7098 Part III sheet with asphalt coating. The metallic screen shall be designed to meet the requirement of the system **short circuit rating of 31.5KA for 3 sec (for 33KV) and 40KA for 3Sec (for 132KV).**

4.3.11 ARMOURING (FOR 33KV CABLE)

a) The armoring shall be of non-magnetic material.

b) Armoring shall be applied over the insulation or protective barrier or non-metallic part of insulation screening, in case of single core cables or inner sheath in case of screened and armoured single core cables.

c) The armour wires/strips shall be applied as closely as practicable the direction of lay of the armour shall be left hand. For double wires/strips armoured cables, this requirement shall apply to the inner layer of wires/strips. The outer layer shall, except in special cases, be applied in the reverse direction to the inner layer, and there shall be a separator of suitable non-hygroscopic material; such as plastic tape, bituminized cotton tape, bituminized hessian tape, rubber tape, proofed tape between the inner and outer layers of armour wires strips.

d) A binder tape may be applied on the armour.

e) The joints in armour wires of strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire/strip shall be at least 300 mm from the nearest joint in any other armour wire/strip in the completed cable, Number of joint in a single wire to be limited.

4.3.12 OUTER SHEATH

The outer sheath shall consist of extruded black colored PE of ST2 grade as per IS: 5831 (1984). The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

4.3.13 RATING

The bidder shall declare current rating of cable for maximum conductor temperature of 90 degree C under continuous operation. A complete set of calculation made in arriving at the current rating shall be furnished for laying condition under present.

4.3.14 CABLE DRUMS

Cables shall be supplied in wooden or steel drums of heavy construction of suitable size and packed conforming to IS 10418 or applicable internationally accepted standards. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum. A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

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

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 hermetically sealed by means of water blocking compound followed by heat shrinkable caps totally coated inside with mastic so as to prevent to cable for moisture penetration during transit, storage and laying.

The bidder shall consider supply of cable on returnable drums basis. Contractor shall take back all the cable drums from site after successful laying, testing and commissioning of cables. If any length of cable remains unused, the same shall be adjusted by the employer.

Embossing of outer sheet: the following details on the other sheet of cable at a regular interval of 1(one) meter.

(a) Name of Customer i.e. AEGCL

(b) Conductor size, type of insulation and voltage grade.

(c) Manufacturer's name.

(d) Year of manufacturing

4.3.15 TESTS

All routine and acceptance tests shall be conducted as per IEC60840/IEC62067. All type tests conducted during last five years from the date of NIT as per IEC 60840:1999/ IEC 62067:2001 including its amendments on the XLPE insulated HT cable should be submitted. The diameter of test cylinder during bending test shall be as per IS:7098 (Part3) or the diameter of drum barrel to be used for dispatch of cables which ever is lower. For accessories type test reports should be submitted as per Clause 11.3.2 IEC 60840:1999/ Clause12.4.2 IEC62067:2001 & including amendments.

Following additional type tests shall be carried out on outer sheath of XLPE insulated HT cable.

a. Oxygen index and temperature index test as per ASTMD-2863.

b. Chemical composition test for verifying lead sheath composition.

All tests as prescribed in IEC-60840 shall be performed after installation of cable.

4.3.16 TESTS AFTER INSTALLATION

All tests as prescribed in IEC-60840:1999/IEC 62067:2001 shall be performed after installation of cable.

4.3.17 TRENCHING

The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.

The trench shall be excavated using manual/ mechanical modes as per field conditions.

Where paved foot paths are encountered, the pavements labs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored.

The sides of the excavated trenches shall wherever required be well shored up.

Suitable barriers should be erected between the cable trench and pedestrian/motor way to prevent accidents. The barriers shall be painted with yellow and black or red and white coloured cross stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights.

The excavated material shall be properly stored to avoid obstruction to public and traffic movement. The bottom of the excavated trench should be levelled flat and from any object which would damage the cable. Any gradient encountered shall be gradual.

4.3.18 PAYING OUT

The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paying out the cable. The cable shall be rolled in the trench on cable rollers, spaced out of uniform intervals. The paying out process must be smooth and steady without subjecting the cable to abnormal tension. The cable on being paid out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed not exceeding 600 to1000 meters per hour.

The cable end seal shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position.

4.3.19 LAYING OF CABLES

The installation, testing and commissioning work for laying of cable in the entire route within the substation, through the outside cable laying corridor as per designated approved route shall mainly consist of:

a) Route survey for the entire route length under the scope of work. This is also to finalize drum wise cable length with their tolerances.

b) Clearances from relevant authorities for lying of cables.

c) Formation of buried cable trenches for cables as per specification including supply and installation of warning tape, protective tiles / brick layer of minimum class designation 50 (50kg./sq.cm.) cable protection covers for entire route, construction of jointing bays, back filling of trenches and restoration as per specification.

d) Road, rail and canal crossings through HDPE pipe for each cable and restoration as per specification.

e) Cable markers as per statutory requirements shall be provided all along the route at a maximum distance of 500 meters and other important locations. Also the location of underground cable shall be clearly indicated on the marker.

f) Supply and installation of straight through joints for complete route.

g) Design, supply and installation of suitable hangers and other necessary structures for running the cable at over head road bridge.

h) Supply and installation of all critical installation materials like trefoil clamps, neoprene cushions, support brackets etc. as required for complete route to avoid damages of the cable. Neoprene cushion shall be provided at road and rail bridge crossings to avoid damage of cable due to vibrations during movement of trains and vehicles.

i) Termination of cables, bonding of screen/sheath to the earth station through disconnecting type link boxes and SVL (sheath voltage limiter) at cable conductor junction-point etc. Bidder shall adopt ends bonding for route under scope as per STP or as per detailed Engineering. Earthing stations/ Earthing pits, earthing materials and earthing conductors wherever applicable for complete route including outdoor equipment, structure, cable terminating structure and earth link box at the locations mentioned above shall be in contractors' scope.

j) Design, fabrication, supply and erection of galvanized steel structures (including its civil foundation) for cable end terminations (with all necessary accessories) for cable sat cable–conductor junction point. At cable-conductor junction point terminal connectors offered by bidder shall be suitable to terminate with ACSR conductors.

k) For termination at GIS substation end the cable should be laid up to GIS building. Necessary design construction of cable duct etc. in the GIS Sub-Station including all supply is within the scope of this contract.

l) Design, supply and installation of LA sat cable–conductor junction point for both the circuits including its mounting structure and Las & Isolator sat Sub-Station.

m) Termination, bonding, earthing etc. at GIS sub-station end is not within the scope of this work.

4.3.20 LAYING OVER PRE-CONSTRUCTED TRENCH

For lay of the cable on a pre-constructed trench below the road in any planned township area, Bridge, switchyards etc., cable shall have to be accommodated in the space allotted in the trench for laying the cables. Sufficient clamping arrangement shall have to be done for fixing the cable properly. Cables may be placed in trefoil arrangements or flat arrangements as per allotted width of the trench. Any damages occurred in the trench during lay of the cable shall have to be repaired properly.

4.3.21 CLAMPS

Clamps shall be pressure die cast aluminium (LM-6) or Nylon-6 or fiber glass and shall include neoprene rubber lining wherever the cable touches the clamps and below the clamp base and necessary fixing non magnetic nuts, bolts, washer etc. The thickness of neoprene rubber shall not be less than 10 mm inside around the inner surface of the trefoil clamp and minimum 20 mm thick below the base of trefoil clamp. The neoprene shall be tested as per ISIII49-1984. Clamps shall be provided at every one meter of cable runs. The contractor shall submit drawings of trefoil clamps and arrangements for Employer approval.

4.3.22 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 surface, 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 general conform to IS1255- 1983 or its equivalent.

4.3.23 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 damages 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.

- At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes of adequate strength using HDD technology.

4.3.24 CABLE ROUTE MARKERS / CABLE JOINT MARKERS

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per drawings supplied by Employer.

Markers provided shall be as per the field requirement, if the route passes through open fields, markers should be conspicuously visible above ground surface.

The marker should incorporate the relevant information, The name of the owner, voltage, circuit and distance of cable from the marker.

4.3.25 DEPTH OF LAYING OF CABLES

Depth of lay shall be normally at 1.5 m. below ground but variation of depth of lay to1 meter may be considered at the time of detailed engineering on the characteristics of the laying zone.

4.3.26 SAND BEDDING

The cable shall be completely surrounded by well-compacted cables and to such a thickness and of such size that the cable is protected against damage. The thickness of the cable sand should normally be a minimum of 10 cm in all directions from the cable surface.

4.3.27 THERMAL BACK FILL

Based on the evaluation of soil thermal resistivity along the cable route and after approval from the Employer the contractor shall design, specify, supply, lay and monitor the installation of thermal back fill surrounding the cables.

4.3.28 IMMEDIATE ENVELOPE TO CABLE

The option on the use of the material that immediately envelopes the cable viz., thermal back fill or sand or sieved native soil rests with the Employer. The contractor shall seek prior approval on the use of the envelop material from the Employer before execution of the works.

4.3.29 BACKFILLING

Normally back filling shall consist of the material earlier excavated. However, bigger stores or pieces of rock should be removed.

4.3.30 WARNING TAPE

A pre-warning, Red colour plastic/ PVC tape, 250 mm wide100 microns thick, shall be laid at approx. 0.4m above the cable specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under

CAUTION: AEGCL ….. KV CABLES.

4.3.31 PREVENTION OF DAMAGE DUE TO SHARP EDGES

After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

Straight and curved rollers used shall have no sharp projecting parts liable to damage the cable.

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. The cables shall never be bent, beyond the specified bending radius.

4.3.32 ROAD, RAIL & CANAL CROSSINGS

The road cutting, whether cement concrete asphalt or macadam road surface, rail crossing and canal crossing shall be taken after obtaining approval from the concerned authorities i.e. Railway authorities, irrigation deptt., civic authorities traffic police, telephone authorities etc. and work should be planned to be completed in the shortest possible time. Where necessary, the work shall be planned during night or light traffic periods. HDPE pipes shall be used for cable. HDPE pipes diameter should not be less than1.5 times the cable diameter.

4.3.33 TRENCHLESS DIGGING

It is envisaged that trenchless digging shall be used for crossing National highways, Rail line and canal and this shall be in the scope of bidder. Trenchless digging shall also be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of underground cables. The trenchless digging methods shall generally conform to ITU-T 1.38. The various methods of trenchless digging such as hand/ manual auguring (upto15m.) impact moulding (from 16m to about 40-50m.). HDD (above40-50m) shall be adopted based on the soil/ site conditions and the requirement and exact method for trenchless digging shall be finalized during detail engineering as per actual site/ soil condition. The equipment used for HDD shall be capable of drilling at least 100m at one go. The contractor shall propose the exact methods and procedures for implementation of trenchless digging at various crossings taking into consideration the following guidelines, for approval by the Employer.

1. Guided boring/drilling technology is to be used.
2. Radio or any detection system should be used for avoiding damage to existing underground utilities.
3. The depth of boring should be such as to clear any underground utilities/obstacles. However, in no case the depth of boring shall be less than 1.65m from the road surface.
4. In horizontal and vertical boring, the system should be capable of going up to 10 meter below ground.
5. The span of HDD will be decided in charge as per site requirements.
6. Excavation and back filling of trial pits and verification of soil condition.
7. Excavation of entry and Exit pits.
8. Erection of drill machined. Drilling of pilot hole.
9. Placement and driving hand augur.
10. Placement and carrying out impact moling.
11. Reaming and widening of bore holes in steps (if required).
12. Pulling of product pipe.

4.3.34 FOOTPATH CUTTING

The slabs, curb stones on the roads shall be removed and reinstated without damage.

4.3.35 REINSTATEMENT

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the Employer. The protective covers shall then be provided the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50mm and not more than 100mm in the center and tape ring towards the sides of the trench.
The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required the temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

4.3.36 MANHOLES

Manholes shall be provided at every proposed joint location for jointing bays. The bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The Contractor shall get inspected by a representative of the Employer, all manholes before carrying out the backfilling. Pipe and cable sealing, installation of joint bus and cable service loops as per approved drawings shall be visually inspected and checked for tightness.

The contractor shall submit design and drawing of Jointing bay including manholes in the buried cable trench portion for withstanding a live load of 20 tons vehicle plus 30% for impact from moving vehicle. The Contractor shall propose a suitable procedure for testing the manhole for approval by the Employer. Manholes type approved by the Employer only shall be acceptable. The manhole shall include sufficient number of suitable entries.

All works shall be carried out under supervision of the engineer in charge of his representative.

4.3.37 TOOLS AND PLANTS

The successful bidder shall have 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 carryout the work successfully and speedily.

4.3.38 BENDING RADIUS:

The minimum bending radius of XLPE insulated cables are as follows:

Cable	Bending radius
Single Core	25 X D
"D" means the overall diameter of the completed cable.	

4.3.39 CABLE END TERMINATIONS & JOINTING

The cable jointing accessories shall include the end terminating kits, straight through joints and also any special tools and tackles required for making these joints.

The straight through joints shall be either Pre-molded Heat Shink type complete with all accessories. The joint shall preferably be built up as per the construction of 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 climatic conditions.

The outdoor end termination up to 245 KV XLPE Cable shall be Anti-fog, Pre-molded type Silicon Rubber stress cone. Torque controlled mechanical shear head bolted connector with polymeric composite housing (resin cast body with silicon shed housing), dry type self-supporting with Plug-in / Plug-out facilities. The termination base plate and the cable's metallic sheath shall be electrically insulated from the self-supporting structure by means of stand-off epoxy insulators designed to withstand both mechanical and electrical stresses in services. The Polymeric insulator in grey colour shall be used. In addition, upon arcing horn and shield ring shall have to be supplied as required for 245 & 420 KV XLPE cables.

The outdoor end termination for 400kV shall be based on the Silicon / EPR-based stress relief cone with the epoxy housing and the oil-impregnated cylindrical capacitor cone (so called condenser cone type) to secure the uniform longitudinal voltage distribution all along the termination. Pre- molded type Silicon Rubber sleeve outdoor end termination for 400kV may be offered by the manufacturer if the same is available.

The outdoor terminals should be suitable for heavily polluted atmospheric conditions with total creepage distance of 31 mm/ kV and protected creepage distance of not more than 50% of the total creepage distance. The cable end terminals for terminating the cables shall be fully compatible with the cables to be supplied.

The Indoor Termination at GIS SF6 Housing shall be based on the Silicon Rubber based stress relief cone and the epoxy resin housing. There shall be mechanical devices to maintain the interface pressure. Stress relief cone and mechanical devices shall be designed to fit with controlled interference over the cable insulation and shall follow the cable's diameter variations still guaranteeing under any service condition a sufficient positive pressure to control the electric field concentration. There shall be epoxy insulating plate to isolate between cable sheath and GIS chamber. The SVLs (Sheath Voltage Limiter) shall be installed to protect epoxy insulating plate from switching impulse. Plug-in type leading conductors shall be supplied though at the time of detailed engineering confirmation shall be given for selection of plug-in type. Design and scope of delivery shall be fully complying with IEC-60859, IEC-62271-209 and possibly adjusted to various needs of project. The main insulation components shall be fully examined and tested in the factory.

The detailed description on jointing procedure shall be furnished during detailed engineering.

The details of the performance of end terminations / straight through joints as offered with the period in service in reputed Indian Utility should be furnished for 145 KV & 245 KV and reputed International/ Indian utility for 420 KV Cable accessories for evaluation of the techno-commercial offer.

The accessories shall be Type Tested as per relevant IEC 60840 & Type test report shall have to be furnished for technical evaluation.

4.3.40 WORKING PROCEDURE FOR TERMINATION

(i) At cable terminating end sufficient length of spare cable shall be left in the ground and at cable tray also at GIS, 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 fiber shroud.

(vii) Providing earth stations with all required materials, like leads, connectors etc. Earthpits shall conform to IS-3043:1987 (Code of practice for earthing).

4.3.41 WORKING PROCEDURE FOR JOINTING

(i)The cable jointing personnel and his crew shall have good experience in the type of jointing and terminations that are used. The jointing works shall commence as soon as two or three lengths of cable 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.

(ii) Jointing of cables in carriage ways, driveways under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and was mains should be avoided wherever possible.

(iii) Sufficient overlap of cables shall be allowed for making the joints.

(iv) The joint bay should be 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. **3 ph link box for cross bonding to be placed inside the bay with provision for easy access for maintenance purpose.**

(v) The joints of different phases shall be staggered in the jointing bay.

(vi) Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.

(vii) The materials used in the joints like ferrules, screen/ sheath continuity bonds, lugs etc. shall be of good quality and conform to standards.

(viii) The jointing tools shall be appropriate and as per the requirement of jointing HVXLPE cables.

(ix) SUMP HOLES-When jointing cables in water logged ground or under unforeseen rainy conditions, a sump hole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or drained out by buckets, without causing interference to the jointing operation.

(x) TENTS/COVERS- An enclosure or suitable protection cover shall be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The joint shall be made in dust free, moisture free and clean atmosphere.

(xi) PRECAUTIONS BEFORE MAKING A JOINT- The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/ inclement weather conditions which might become uncontrollable. If the cable end seals of cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

(xii) MEASUREMENT OF INSULATION RESISTANCE- Before joining, the insulation resistance of both sections of cables shall be checked.

(xiii) 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.

4.3.42 BONDING OF SCREEN/ SHEATH

The screens at both ends, shall be brought out and bonded to the earth station through disconnecting type link boxes or through SVL wherever applicable.

On the basis of the length of the cable and rise of sheath Voltage the bonding maybe required as follows:

1. Single End Bonding

2. Double End Bonding
3. Cross Bonding
4. Mid point bonding

All accessories and consumables used in the termination should be of good quality and compatible with the cable. At the time of single end bonding parallel copper conductor along the length of the cable shall have to be provided between the two ends of the cable. Bonding cable of 6.6KV copper shall be provided for bonding of metallic sheath/ Screen.

4.3.43 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.

4.3.44 STATUATORY APPROVAL OF WORKS

Contractor shall make an application on behalf of the owner for submission to the Electrical Inspectorate along with copies of required certificates complete in all respects and submit to the engineer-in-charge for onward transmission well ahead of time so that the actual commissioning of system/ equipment is not delayed for want of inspection by the Inspector. Contractor shall arrange the actual inspection of work by the Electrical Inspector. Necessary coordination and liaison work in this respect shall be the responsibility of the contractor.

The Inspection and acceptance of work as above shall not absolve the Contractor from any of his responsibilities under this contract.

Any other statutory approval of works required for the electrical installation (such as Factory Inspector, CCOE, etc.) is also included in contractor's scope.

Supply & execution of job is subjected to regulations time to time framed by the AERC; approval Govt. Of Assam, and NOC from Assam Pollution Control Board. Contractor shall complete the entire job in compliance with the same.

4.3.45 INSPECTION, TESTING AND COMMISSIONING

Inspection of Supplied materials and Site works time to time during execution: Inspection of AEGCL and clearance from AEGCL will be in Contractor responsibility. Expenditure related to this inspection will be in contractor account. Site inspection, testing and commissioning of electrical installation shall be carried out as per enclosed Specification and Inspection and Test Plans included or referred in this BID. All the equipment installed by the contractor shall be tested and commissioned, as required and no separate payments shall be made unless otherwise specified in the Schedule of Rates. Contractor shall carefully inspect all equipment and submit the manufacturer's Certificate before installation. Any damage or defect noticed shall be brought to the notice of the engineer-in-charge at that time and same shall be rectified or replaced by CONTRACTOR on his OWN RISK AND COST within TIME FRAME. Complete testing of power transmission system would be carried out under the supervision of the Employer.

Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at his own cost.

The contractor shall carry out all the tests as enumerated in the tender and technical specifications and technical documents which may be furnished to him during performance of the work.

Before the electrical system is made live, the electrical contractor shall carry out suitable tests to establish to the satisfaction of the Employer that the installation of equipment, cabling/ wiring and connections have been correctly done and are in good working condition and that the system/ equipment will operate as intended.

All tests shall be conducted in the presence of Employer/ Engineer-in-Charge or his authorized representative unless he waives this requirement in writing. Contractor shall arrange testing equipment, as required to carry out the tests. Test results shall be recorded on approved Performa and certified records of the tests shall be submitted to the Employer/ Engineer-in- Charge.

Prior intimation to be given to the Employer before finalizing of date of scheduled inspection at least 15 days in advance.

Clearance in favour of contractor for dispatch of equipment/material from respective works of manufacturer will be covered by the Employer after physical inspection and witnessing satisfactory routine and acceptance tests. Contractor will have to arrange physical inspection and witnessing of Routine and Acceptance Test of materials/equipments at respective manufacturer's works by two engineer of the Employer and cost of such inspection shall have to be borne by contractor. Clearance for dispatch of equipments & materials from respective works of manufacturers will be conveyed by the Employer after verification and acceptance thereafter.

After the completion of all tests and rectification of all defects pointed out during final inspection, plant start-up trials shall commence. During the start-up trials, contractor shall provide skilled/ unskilled personnel and supervision round the clock at his own cost. The engineer-in-charge/Employer will decide the number and the category of workmen and their duration. Any defects noticed during the start-up trials relating to the equipment supplied and work carried out by the contractor, shall be rectified by the contractor at his own cost.

The Employer shall have the right to get the defects rectified at the risk and cost of the contractor if he fails to attend to the defects immediately as desired.

Contractor shall also inform the Employer/ Engineer-in-charge, well in advance in case services of any OEM (Equipment manufacturer) are required and same shall be arranged by Contractor at the time of commissioning on his own cost.

Contractor shall furnish site acceptance test (SAT) procedures from the equipment supplier and get it approved from the Employer/ Engineer-in-charge before carrying out the same at site.

Contractor shall prepare detailed testing, pre-commissioning and commissioning procedures for the entire installation. These shall include Performa for defining activities and recording of test results.

It is the responsibility of the contractor to coordinate and provide all necessary assistance to other contractors / agencies/ vendors involved in the complex for proper and timely execution of the works. Further contractor shall do all the liaisoning, documentation or other related formalities with respective authorities/agencies for successfully charging/commissioning of system.

The following equipment/ items as included in Contractor's scope of supply shall be tested and inspected by the Employer or his authorized representative before dispatch at the manufacturer's works. Test certificates duly signed by the Employer or his authorized representative shall be submitted by the contractor as part of the final document:

a. EHV cable & optical fiber cables.

b. Jointing & termination kits for above items

4.3.46 ENGINEERING DATA AND DRAWINGS

The Bidder shall necessarily submit all the drawings/ documents unless anything is waived. The Bidder shall submit 4(four) sets of drawings/ design documents/ data/ test reports as may be required for the approval of the Employer.

All drawings submitted by the Bidder including those submitted at the time of bid 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 and the external connections, fixing arrangement required and any other information specifically requested in the specifications.

All engineering data submitted by the Bidder after final process including review and approvalbytheEmployershallformpartoftheContractDocumentandtheentireworks performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

4.3.47 INSTRUCTION MANUAL

(i) 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.

(ii) If after the commissioning and initial operation, the instruction manuals require any modifications/ additions/ changes, the same shall be incorporated by the bidder in the final submission.

(iii) The Bidder shall furnish to the Employer catalogues of spare parts.

4.3.48 QUALITY ASSURANCE PROGRAMME

a. To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Bidder's Works or at his sub-bidder's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Bidder shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Bidder and shall befinally accepted by the Employer after discussions before the award of Contract.

b. Quality Assurance Documents

The Bidder shall be required to submit the following Quality Assurance Documents within three weeks before laying/ erection of the equipment.

(i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

(ii) Welder and welding operator qualification certificates.

(iii) Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.

(iv) Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

(v) Stress relief time temperature charts/ oil impregnation time temperature charts.

(vi) Factory test results for testing required as per applicable codes/ mutually agreed quality plan/ standards referred in the technical specification.

(vii) The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

4.3.49 EQUIPMENTS & STRUCTURES FOR CABLE TERMINATION

1. The terminating structure being provided should be designed as per the requirement of the cable end sealing, porcelain bushing etc. The mounting structure shall be fixed on the cement concrete foundation, the design and drawings of which shall be submitted to Employer for review and acceptance during the course of detailed engineering. After fixing the end termination, the cable shall be fixed to the support, with non- magnetic material clamps to the required height securely. The mounting structure includes the supports for cable end boxes, link boxes and any other structure required for the intent of the contract. All steel sections used shall be free from all imperfections, millscales, 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.

2. Suitable fencing should be provided at the cable terminating yard at cable conductor junction point. The fencing will consist of galvanized steel XPM structure over a brick wall of 2(two) feet meeting electrical requirement (IE). A suitable entry point (gate) has to be provided.

3. Outdoor type 120KV lightning arresters for each cable of both the circuits are to be provided at cable-conductor junction point. The technical specification of lightning arresters is given separately **in** this volume.

4. It is recognized that the Bidder 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 the Employer. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification andthe catalogues or the bid, if not clearly brought out in the specific requisite schedule will not be considered as valid deviation.

5. 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 but which are necessary for commissioning and satisfactory operation of the work 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.

6. STEEL STRUCTURES (GANTRY, EQUIPMENTS ETC.):

A) The contractor shall assume full responsibility for supply, fabrication and detailing, if required of the steel structures and for their satisfactory performance. All detail drawings for the structures shall be supplied to the successful bidder by the Employer/Engineer. However, the contractor shall have to submit the construction drawings to the Engineer/Employer solely prepared on the basis of these supplied drawings. Equipment Structure drawings, supplied by the employer, shall have to be modified to suit to the approved GA drawings of the equipment and electrical layout drg. And to be submitted to Engineer for approval. Employer/ Engineer shall have the right to instruct the contractor to make any changes in details necessary to make the construction conform to the requirement of the Contract Document.

B) The contractor shall supply all materials, deliver the same to site, and provide all labour, erection plant and equipment, fixtures, fitting and all temporary and permanent works necessary for satisfactory completion of the job in all respects.

C) No omissions or ambiguities on the drawings or in specifications will relieve the contractor from furnishing best quality of materials and workmanship. Should any inaccuracies be found, the contractor shall promptly notify the Employer/Engineer without carrying out the job and no further work shall be done before these discrepancies are corrected. Continuation of further work shall be done only after such discrepancies are rectified at contractor's risk and responsibility.

D) MATERIALS: The materials shall conform to the following requirements:

All Structural Steel Materials to be used in construction within the purview of the specification shall comply with :IS:2062 –Structural Steel (Grade-A) (fusion welding quality) and manufactured by Prime Rollers e.g. SAIL/ TISCO/ IISCO/ RINL. In case of MS sections not manufactured by prime rollers or such sections are not available with prime rollers the same is to be procured from approved conversion agents of prime manufacturer(s).In such case, prior approval of the Engineer is to be obtained by the contractor.

Successful bidder on receipt of structural drawing from department shall submit within 15 days, a detailed raw material procurement plan indicating MS section wise producers name to the Engineer for approval. On according approval in this aspect, work for fabrication protos shall be taken up in hands. Entire fabrication job of MS structural shall not be entrusted to more than two sub- vendors. Further, a list of bonafide fabricators, not exceeding 6 (six) shall be furnished to the Engineer for according approval within 15(fifteen) days from the date of handing over of drawings.

All electrodes to be used under the contract shall comply with any of the following Indian Standard Specifications as may be applicable.

i) *IS:814: Covered electrodes for metal arc welding of Structural Steel.*

ii)*IS:815: Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.*

iii) *IS:144: Covered electrodes for the metal arc welding of high tensile structural steel.*

All bolts and nuts shall be of grade 5.6HRH and shall conform to the requirements of IS:6639 and IS:1367 and galvanizing quality shall be as per IS:1367. All bolts and nuts shall be of minimum diameter of 16mm unless otherwise stated. All mildsteel for bolts and nuts when tested in accordance with the following Indian Standard specification shall have a tensile strength of not less than 44Kg/Sq.mm. and a minimum elongation of 23 percent on a gauge length of 5.6A, where `A' is the cross sectional area of the test specimen-

i) IS:1367: Technical supply conditions for threaded fasteners.

ii) IS:1608: Method for tensile testing of steel products other than sheet, strip, wire and tube.

Washers shall be made of steel conforming to IS:226, IS:961 as may be applicable under the

provisions of the contract and shall be electrogalvanized.

7. FASTNERS & CONNECTIONS:

a)BOLTS: All connections shall be bolted with 16mm bolts.

b)SPLICES: Splicing shall be avoided unless the length of a member exceeds 6.0 m or so. The member of splices shall be limited to a practical minimum. No credit shall be allowed for bearing on a butting areas. Lap joints in leg members shall be preferred to butt joints.

c)STEP BOLTS: Step bolts shall be of 16mm diameter and shall have round or hexagonal head. Each step bolt shall be provided with two hexagonal nuts. The minimum bolt length and length of unthreaded portion shall be 180 and 125mm respectively. Step bolts shall not be used as connection bolts. The step bolts shall be spaced alternately on the inner gauge line on each face of the angle about 40 cm centers. They shall be furnished for one leg of each steel structure column from its base elevation.

d)U – BOLTS: U-Bolts shall be suitable furnished or steel structures to suspend or terminate insulator strings or ground wire assemblies. Size of U-bolt shall withstand all loads acting on it.

e)BILL OF MATERIAL: Bill of material shall give the size, length and weight of each member and the total weights of steel structures. It shall also include the number of bolts, nuts and washers per structure.

4.3.50 MATERIAL/ WORKMANSHIP

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.

In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer the Bidder 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 Bidder.

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 Employer.

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.

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, leveling, 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.

Provision 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 mild dew.

4.3.51 **PACKAGING & PROTECTION**

a. All the equipment 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 Employer, the Bidder shall also submit packing details/ associated drawing for 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 in India should be taken into account. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railway etc. shall be to the account of the Bidder. Employer takes no responsibility of the availability of the wagons.

b. 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 piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damaged. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

4.3.52 FINISING OF METAL SURFACES

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 and bolts and spring washers shall be electro galvanized to service condition. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized accordingtoIS:2629.

HOT DIP GALVANISHING- The minimum weight of the zinc coating shall be 610gm/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. 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 610gm/sqm minimum.

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.

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.

The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS- 2633.

Sharp edges with radii less than 2.5mm 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 Indian Standards

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

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

PAINTING

All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall be forehand 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.

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.

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.

The exterior color of the paint shall be as per shade no: 697 of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Each coat of primer and finishing paint shall be 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.

In case the Bidder proposes of follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids of Employer's review and approval.

4.3.53 **HANDLING, STORING AND INSTALLATION**

a. In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Bidder shall unload, store, erect, install, wire, test and place in to commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workman like 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 energization at rated voltage.

b. Bidder 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. Bidder 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.

c. In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer's drawings or instruction, necessary clarifications shall be obtained from the Employer. Bidder shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings / instructions correctly. Where material/ equipment is unloaded by Employer before the Bidder arrives at site or even when he is at site. Employer by right can hand over the same to Bidder and there upon it will be the responsibility of Bidder to store the material in an orderly and proper manner.

d. The Bidder shall be responsible for making suitable indoor storage facilities to store all equipment, which require indoor storage.

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

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

g. 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 Bidder shall immediately proceed to correct the discrepancy at his risks.

132KV Suspension and Tension Insulator Hardware Fittings with Insulators: will be as per standard technical specification of Sub-Station Projects of AEGCL.

4.3.54 QUALITY CONTROL:

The contractor shall establish and maintain quality control procedures for different items of work and materials to ensure that all work is performed in accordance with the specifications and best modern practice.

In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer. As far as possible all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at site or elsewhere. The contractor shall cooperate with the Engineer in permitting access for inspection to all places where work is being done and in providing free of cost of all necessary help in respect of tools and plants, instrument, labour and material required to carry out the inspection. Materials or workmanship not in reasonable conformance with the provisions of this specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

i) Steel: Quality, manufacturer's test certificates, test reports including procurement in-voice of representative samples of materials from unidentified stocks if permitted to be used.

ii) Bolts, nuts & Washers: Manufacturer's certificate, dimension check, material testing

iii) Electrodes: Manufacturer's certificate, thickness and quality of flux coating.

iv) Welds: Inspection, X-ray, ultrasonic test, magnetic particle tests as required

v)Paints: Manufacturer's certificate, physical inspection reports.

vi) Galvanizing: Tests in accordance with IS:2633 – Method of testing uniformity of coating on zinc coated articles and IS:2629 Recommended practice for hot - dip galvanizing of iron and steel. Raw zinc & samples collected from bath shall be tested at third party laboratory as per direction of the Engineer. The contractor shall submit a detailed material inspection plan on the basis of various IS codes & standard practices in respect of structural fabrication, galvanization, bolts, nuts, anchor bolts etc. much prior to commencement of the job.

4.3.55 FABRICATION WORKMANSHIP:

All workmanship shall be equal to the best practice in modern structural shop and shall conform to the provisions of IS:800/ IS:802.

Rolled materials before being laid off or worked, must be clean free from sharp kinks, bends, or twists and straight within the tolerances allowed by IS:1852. If straightening is necessary it may be done by mechanical means or by the application of a limited amount of localised heat not exceeding 600^{o}C.

Cutting shall be effected by shearing, cropping or sawing. Use of mechanically controlled Gas Cutting Torch may be permitted for mild steel provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. To determine the effective size of members cut by gas, 3mm shall be deducted from each cut edge.

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2mm at each end. The erection clearance at ends of beams without cleats shall not be more than 3mm at each end, but where for practical reasons greater clearance is necessary, suitably designed clearance shall be provided.

All members shall consist of rolled steel sections.

Holes for bolts shall not be more than 1.5mm larger than the diameter of the bolt passing through them unless otherwise stated.

All members shall be cut to jig and all hole shall be punched and drilled to jig. All parts shall be carefully cut and holes accurately located after the members are assembled and tightly clamped or bolted together.

Drifting or rimming of holes shall not be allowed. Holes for bolts shall not be formed by gas cutting process.

Punching of holes will not be permitted for M.S. members upto 8mm thick and in no case shall a hole be punched where the thickness of the material exceed the diameter of the punched hole.

Minimum bolt spacing and distances from edges of members shall in accordance withthe provisions in the relevant Indian Standard Specification.

Built members shall, when finished, be true and free from all kinds of twists and open joints and the material shall not be defective or strained in any way.

All bolts shall be galvanized including the threaded portion except the foundation bolts for which galvanizing work shall be done for a length of 100mm (min) to 175mm (max) measured from the tip of the treaded portion. The threads of all bolts shall be cleared of smelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the Engineer. All nuts shall be galvanized with the exception of the threads which shall be oiled. In case of foundation bolts the same shall be galvanized excepting the length of embedment. When in position all bolts shall project through the corresponding nuts but not exceeding 10 mm. The nuts of all bolts attaching insulator sets and earth conductor clamps to the structure shall be carefully positioned as directed by the Engineer.

Bolts and nuts shall be placed in such a way so that they are accessible by means of an ordinary spanner.

Foundation bolts shall be fitted with washer plates or anchor angles and flats, nuts etc. and shall be manufactured from mild or special steel.

Washers shall be tapered or otherwise suitably shaped, where necessary to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least by 3mm. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut. In addition to the normal washer, one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified in the drawings.

The thickness of spring washer shall be 3.5 mm for bolt diameter 16 mm and 4 mm for bolt diameter 20 mm.

4.3.56 CLEANING & GALVANIZING:

CLEANING:

After fabrication has been completed and accepted, all materials shall be cleared off rust, loose scale, dirt, oil grease and other foreign substances.

GALVANIZING:

All materials shall be hot-dip galvanized after fabrication and cleaning. Re tapping of nuts after galvanizing is not permitted.

Galvanizing for structural mild steel products shall meet the requirements of IS:4759. All holes in materials shall be free of excess spelter after galvanizing.

Galvanizing for fasteners shall meet the requirements of IS:1367. The spring washers shall be

electrogalvanized as per IS:1573.

Finished materials shall be dipped in to the solution of dichromate after galvanizing for white rust protection during transportation.

All galvanizing shall be uniform and of standard quality. Quantity of zinc shall meet the requirement of IS:209.

Mass of Zinc Coating:

The mass of zinc coating for different class of materials, as given in Table below, shall be followed:

MASS OF ZINC COATING

Sl. No.	Product	Electro meter reading (micron)	Minimum value of average mass of coating
i)	Casting - gray iron, malleable iron		610 (gm/m2)
ii)	Fabricated steel articles :		
a)	5 mm thick and over	86	610
b)	Under 5 mm, but not less than 2 mm	65	460
c)	Under 2 mm, but not less than 1.2mm	48	340
iii)	Threaded work other than tubes and tube fittings :		
a)	10 mm dia and over	43	300
b)	Under 10 mm dia	39	270

4.3.57 STRAIGHTENING AFTER GALVANIZING:

All plates and shapes which have been warped by the galvanizing process shall be straightened by being rerolled or pressed. The materials shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If, in the opinion of Employer/ Engineer the material has been forcibly bent or warped in the process of galvanizing of fabrication, such defects shall be cause for rejection.

4.3.58 REPAIR OF GALVANIZING:

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized, unless, in the opinion of Engineer, the damage is local and can be repaired by zinc spraying or by applying a coating of galvanizing repair compound. Where re-galvanizing is required, any member which become damaged after having been dipped twice shall be rejected.

4.3.59 SHOP ASSEMBLY:

One of each type of steel structures shall be assembled in the shop to such an extent as to ensure proper field erection in order to facilitate inspection by the Engineer.

4.3.60 SHOP TEST:

The following shop tests shall be performed with relevant provisions of I.S. Codes :

a) *General Inspection*

b) *Material test.*

c) *Assembly test.*

d) *Galvanizing test.*

The contractor shall furnish four certified copies of reports of all tests to the Engineer.

4.3.61 **FOUNDATION WORKS:**

GENERAL REQUIREMENT:

The design of RCC foundation for gantry and other equipment structures to be constructed shall be the responsibility of the contractor. All design of RCC foundation works shall conform to IS: 456 (2000) unless otherwise mentioned herein. All designs and details shall be subject to approval of the Engineer. Effect of additional surcharge due to earth filling shall duly be taken into account during design.

However, detailed foundation design shall be based on the actual soil parameters which shall be ascertained by the intending bidder. Any variation in design of foundations due to change in soil parameters during execution of work shall not affect the terms of the Contract. No extra payment on account of any change what so ever in soil parameters will be entertained.

DESIGN OF FOUNDATIONS:

STEEL STRUCTURE FOUNDATIONS: The foundations shall be designed such that the upper structure shall be securely supported. Any unequal displacement that may cause harmful effect to the upper structures shall not be allowed. The safety factors for strength and stability of the foundations shall be as per relevant code.

The overload factor shall be taken as 1.1 for designing foundations of all gantry and equipment. The loads, shear and moment values shall be multiplied with this overload factor, so as to obtain the design values.

ELECTRO-MECHANICAL EQUIPMENT FOUNDATIONS:

The foundation shall be so designed that the upper equipment shall be securely supported. The effect of vibration of the equipment, impact load when in operation and over turning force due to abnormal condition of equipment shall be considered in foundation design. The safety factor for stability of the foundations shall be as per relevant code with an overload factor of 1.1.

Following minimum values shall be used while designing foundations :

- Minimum base slab thickness of footings : 200mm
- Minimum bar dia for foundation: 10 mmTOR
- Minimum bar dia for columns :12mmTORwith binder spacing limited to 190 mmc/c
- Clear cover to: Main bars in base slab : 50 mm
- Main bars in columns : 40 mm Main bars of beams : 40 mm

i. Minimum reinforcement for base slab shall be 0.2 percent of cross-sectional area, depth to be considered as effective depth and where beam slab mechanism will be deployed 0.12 percent of gross cross-sectional area shall be considered.

OTHER DETAILS

A) DETAIL DESIGN CALCULATION:

Detail design calculations for each type of foundation shall be submitted for approval of Engineer. Such details shall show the following requirements.

i) Detailed calculation of loads acting on foundation under different loading conditions.

ii) Calculated safety factor for each type of stability and other conditions.

iii) Maximum stresses in concrete and in steel reinforcement at any critical section.

B) LINE AND GRADE:

The contractor shall set all lines and grades or elevation of the ground at all footings and set the necessary stakes that are required for the work and will be responsible for their accuracy. Employer/ Engineer may check lines and levels set by the Contractor from time to time, and inadequacies if any, shall be rectified by the contractor as per the direction of the Engineer, but the responsibility for their accuracy shall rest entirely with the Contractor.

C) DETAIL DRAWINGS: Details of each type of foundation submitted for Employer's/ Engineer's approval shall be as shown on the approved design drawings and shall conform to the requirements described hereafter. No change shall be made without the written approval of Employer/ Engineer. The detail drawings shall include but not limited to the following:

i) Detail dimensions of foundation.

ii) Details of setting dimensions of foundation.

iii) *Details of placing of all reinforcing steel which shall conform to the Building Code Requirements for Reinforced Concrete (IS:456) and the Manual of Standard Practice for Detailing Reinforced Concrete Structure unless otherwise specified herein.*

iv) *Details of type size and length of each reinforcing steel including schedule of bar bending to be submitted to the Engineer at site*

4.3.62 WEIGHT OF SUB-STATION STRUCTURES:

Self-weight of line tower, A-frame and equipment structures for different gantry and equipment structures shall be provided at the time of detail engineering.

Technical Specification for Underground Fibre Optic Cable

This section describes the functional requirements, major technical parameters and Type testing, Factory Acceptance Testing & Site Acceptance Testing requirements for underground fibre optic cables and HDPE pipes. Marking, packaging, transportation & installation requirements have also been described. The payment will be made for the executed route length only. However, specified service loops and lengths for wastage, installation/working for FO cable & HDPE ducts shall be considered as required by the bidder for which no additional payment will be made.

General

The underground fibre optic cable shall be armoured and shall be suitable for direct burial as well as for underground installation in pipes. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport. The fibre optic cable shall be a UV resistant, rodent proof. The underground fibre optic cable (UGFO) shall be offered from a manufacturer who has been manufacturing UGFO for the last five (5) years and UGFO manufactured & supplied by such manufacturer shall have been in satisfactory operation.

Applicable Standards

The cable shall conform to the standards named below and the technical specifications described in the following sections.

i). ITU-T Recommendations G.652

ii). Electronic Industries Association, EIA/TIA 455-78A, 455-3A/33/41/25A / 81A / 82B, 455-62A, 455-164A/167A/174, 455-168A/169A/170/175A, 455-

176, 455-59, EIA/TIA 598, EIA 455- 104.

iii) International Electro technical Commission standards, IEC60304, IEC60794- 1-2, IEC60811-5-

iv) Bellcore GR-20

v) Indian Railways standard specification no IRS:TC55(Oct 96) (including all amendments)

vi) ASTM:A167-92,ASTM:751-92b,ASTM:A751-92,ASTM:A370- 82,ASTM:D2581- 91,ASTM:D2287-81, ASTM:D 638 for FRP, ASTM :D 217,556, 93-IP-34 for Jelly, ASTM:D570,211 for PBTP, ASTM:D1505for Poly Carbonate, ASTM:D1633,150 for HDPE.

Fibre Type(s) and Counts

The Cable shall consist of 24 fibres Dual-Window Single mode (DWSM), G.652 optical fibres and shall meet the requirements stipulated in Table 1

DWSM Optical Fibre Characteristics(Table-1)

Fibre Description:	Dual-Window Single-Mode	
Mode Field Diameter:	8.6 to 9.5 µm (± 0.6 µm)	
Cladding Diameter:	125.0 µm +/- 1 µm	
Mode Field concentricity error	≤0.6%	
Cladding non-circulatory	≤ 1%	
Cable Cut-off Wavelength λcc	≤ 1260 nm	
1550 nm loss performance	As per G .652	
Proof Test Level	≥ 0.69 Gpa	
Attenuation Coefficient:	@ 1310 nm	≤ 0.35 dB/km
	@ 1550 nm	≤ 0.21 dB/km
Chromatic Dispersion;	18 ps/(nm x km) @ 1550 nm	
Maximum:	3.5 ps/(nm x km) 1288-1339 nm	
	5.3 ps/(nm x km) 1271-1360 nm	
	1300 to 1324 nm	
Zero Dispersion Wavelength:	0.092 ps/(nm^{2}xkm) maximum	
Zero Dispersion Slope:		
Polarization mode dispersion Coefficient	≤0.2 ps/km$^{\wedge 1/2}$	
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60^{0}C - + 85^{0}C)	
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤0.05 dB @ 1550 nm (30±1 mm radius Mandrel) 100 turns;	

	Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

4.3.63 General Cable Construction

Consist of a central fibre optic unit protected by one or more layers of helically wound anti- hygroscopic tape or yarn. The central fibre optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc. The fibre optic unit shall be of loose tube construction. The inner polyethylene jacket and outer sheath jackets shall be free from pinholes, joints, splits or any other defects. All fibre optic cable shall have a minimum service life span of 25 years. The cable construction and mechanical parameters for the Armoured OFC shall be as specified in the Table 2 below.

Table 2

Armoured Cable Construction and Mechanical Parameters

Parameter	Units	Description
No of fibres in the cable		24
Type of fibres in the cable		G.652
No. of loose tubes		Minimum 2
Cable design life		More than 25 years

Colour Coding & Fibre Identification

Individual optical fibres within a fibre unit, and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme. The colour coding system shall be discernible throughout the design life of the cable. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres are included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibre shall be suitably bundled, tagged, and identified at the factory. The colouring scheme shall be submitted along with the cable DRS/drawing for Employer's approval.

Strength Members

The armoured optical fibre cable shall have solid non-metallic strength member(s)/ Solid metallic member(s) or the combination of both. The metallic strength member shall be of high grade steel wire, music spring quality as per ASTM-A228/A228M-93 and shall have suitable chemical coating for proper adhesion with sheath material. The central fibre optic unit should include a central strength member of non-metallic Fibre Reinforced Plastic (FRP) only. Peripheral strength members and aramid yarns are also acceptable. The central FRP strength member may be of slotted type with SZ lay (reverse oscillation lay) of fibre units or it may be cylindrical type with helical or SZ lay of fibre units. The

construction of the central strength member shall be such as to meet the mechanical strength requirements specified in this specification.

Filling Compound

The interstices of the central fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per **IEC60794-1-2-F5**. The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The filling compound shall remain stable for ambient temperature up to +70°C and shall not drip, flow or leak with age or at change of temperature. Reference method to measure drip point shall be as per **IEC 60811- 5-1** and drip point shall not be less than 70°C.

The Sheath / Inner jacket

The Sheath shall be made of High Density Polyethylene-HDPE (Red /Black) and shall be smooth, concentric, and free from holes, splits, blisters and other surface flaws. The sheath shall be extruded directly over the central fibre optic unit and shall also be non-hygroscopic. The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The sheath shall be made from good quality of weather resistant polyethylene compound HDPE and thickness shall be > 1.5mm including the strength member if used in the sheath.

Armouring of cable

Over the inner PE sheath armouring and outer sheath shall be provided to make the cable termite and rodent proof. The thickness of the stainless steel alloy armour shall be > 0.125mm. The steel armour shall be both side coated with a copolymer of thickness > 0.05mm so as to bond the armouring to the outer jacket and make a unitary construction. Stainless steel shall be armouring corrugated transversely for lateral strength and bending flexibility to be applied longitudinally with an overlap of 10% (minimum) over the inner PE sheath. The corrugation over the entire length of the tape used in the cable shall be uniform, electrically continuous (applicable to all metallic elements used in the cable) and bonded to the outer sheath. The force of adhesion of the armour to the outer sheath shall be minimum 14 Newton and shall be tested as per ASTM:4565 test method. Suitable glue adhesive should be provided in between overlap portion of cable armouring for bonding to avoid ingress of moisture (below the armour). The height of the corrugation shall be 0.6mm (min.) and the pitch shall be 2.5mm(max.). Height and pitch of corrugation shall be measured between crest and tough base line. The corrugated armouring of stainless steel shall offer excellent corrosive resistance and shall be AISI Alloy no. 304 and the chemical composition and mechanical properties of steel shall be as specified in table 1 & 2 of ASTM : A167-92b for AISI 304 respectively.

The Outer Jacket

A non-metallic moisture barrier sheath (Red or Black in colour) shall be applied over the armour, which shall consist of tough weather resistance made of HDPE. The thickness shall be uniform and shall not be less than 2.0mm (Red in colour) for the cable having inner and outer HDPE sheath. The outer jacket shall have smooth finish and shall be termite resistant. The raw material and additive used to make the outer sheath termite proof shall be clearly mentioned by the manufacturer of the cable.

In case of HDPE material black in colour is used, the material from finished product shall be subjected to the following tests mentioned in Table 3 below:

Table 3	
1.Density	0.94 to 0.965 gm/cc
2.Melt flow index	< 0.8 gm/10 minutes at 1900 C
3.Carbon black content	(2.5+0.5)%
4.Carbon black Dispersion	Uniform dispersion
5.ESCR	No crack till 48H in 10% Igepal solution 50^0C
6.Moisture Content	<0.3% for 24H, ASTM D570
7.Tensile strength and Elongation at break	>2 Kg.mm^2 and > 500% respectively

Rip Cord: Suitable rip cord(s) shall be provided to open the outer sheath of the cable. The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

Mechanical Parameters & Tests: The offered cable shall meet requirement of mechanical characteristic & tests specified in this specification.

Cable drums, Marking, Packaging and Transport

All optical fibre cable shall be supplied on strong wooden drums provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. The cable drum shall be suitable to carry underground fibre optic cable of required length. However, the exact lengths for drums to be supplied for each link shall be determined by the Contractor during detailed engineering/survey. Drum schedule shall be approved by the Employer before manufacturing the FO cable. Both cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with arrows to indicate the direction of rotation. Both the ends of the cable shall be provided with pulling eye. The pulling eye and its coupling system should withstand the same tensile load as applicable to the cable. The following marking shall be done on each side of the cable drums.

i) Drum number

ii) Consignee's name and address

iii) Contractor's name and address

iv) Type of cable

v) Number of fibres

vi) Type of fibres

vii) Year of manufacturing, month & batch no

viii) Name of manufacturer

ix) Total cable length

x) Inner end marking and Outer end marking

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum and following additional information: OTDR length measurement of each fibre and Ratio of fibre and cable length.

4.3.64 Optical fibre cable marking

A suitable marking shall be applied in order to identify this cable from other cables. Marking on the cable shall be indelible, of durable quality, shall last long and shall be applied at regular interval of one-meter length. Marking shall be imprinted and must clearly contrast with the surface and colours used must withstand the environmental influences experienced in the field. The accuracy of the sequential marking must be within + 0.5% of the actual measured length. The sequential length marking must not rub off during normal installation. In case laser printing is used the marking shall not exceed 0.15 mm depth. The optical fibre cable shall have the following markings in every meter.

i) Type of Cable

ii) Running meter length

iii) Number of fibres

iv) Type of fibre

v) Laser symbol & caution notice

vi) Year of manufacture and batch no.

vii) Manufacturer's name

viii) Owner's Name

4.3.65 Operating Instructions

Complete technical literature in English with detailed cable construction diagram of various sub-component with dimensions and test data of the cable shall be provided. All aspects of installation shall also be covered in the handbook.

4.3.66 Test and Inspection:

`Type Testing

The Bidder shall offer only the type tested cable and submit along with their bid the earlier carried out type test reports for the offered fibre optic cable meeting the requirement. The Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in Table below. The fibre should have been type tested as per relevant International standards for the tests listed in Table below and the Bidder shall submit the test reports and certificates along with the bid. The Contractor shall submit the type test reports of fibres meeting the minimum requirement specified in Tables below.

Type Tests Fibre Optic Cable TABLE-4

S. No	Test Name	Test Procedure
1	Water Ingres Test	(IEC 60794-1-F5/EIA 455-82B) Test duration:24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning: 72 hours, Test duration: 24 hours

3	Crush test	IEC 60794-1-E3/EIA 455-41)
4	Impact test	(IEC-60794-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A)-2 cycles

Type Tests Fibre Optic Cable TABLE-5

S. No	Test Name	Acceptance Criteria	Test Procedure
1	Attenuation	As per TS	IEC 60793-1-40 or EIA/TIA 455-78A
2	Attenuation Variation with wavelength		IEC 60793-1-40 or EIA/TIA 455-78A
3	Attenuation at Water		IEC 60793-1-40 or EIA/TIA
	Peak		455-78A
4	Temp Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 or EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend Performance)		IEC 60793-1-47 or EIA/TIA 455-62A
6	Mode Field dia.	As per TS	IEC 60793-1-45 0r EIA/TIA 455-164A/167A/174
7	Chromatic dispersion		IEC 60793-1-42 or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 or EIA/TIA 455-176
10	Core-Clad concentricity error		IEC 60793-1-20 or EIA/TIA 455-176
11	Fibre Tensile proof testing		IEC 60793-1-30 or EIA/TIA 455-31B

Factory Acceptance Testing

The tests listed in Table below shall be carried out as Factory Acceptance Test for Underground fibre optic cable meeting the requirements specified in this section.

Factory Acceptance Tests on Underground Fibre Optic Cable

Sl. No	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455-78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455-78A or OTDR
3	Visual Material verification dimensional checks as per approved drawings

4.3.67 PLB HDPE PIPE and ACCESSORIES

The following paragraphs describe the functional requirements, major technical parameters and Type and Factory Acceptance Testing requirements for Permanently Lubricant High Density Polyethylene (PLB HDPE) Pipe. PLB HDPE pipe shall be suitable for underground fibre optic cable installation by blowing as well as conventional pulling. The PLB HDPE pipe shall be suitable for laying in trenches by directly burying, laying through G.I/RCC hume pipe and laying through trench less digging. The expected service life of HDPE pipe and accessories shall not be less than 50 years. The unit rates quoted in the price schedule shall be the composite price of PLB HDPE pipe along with all accessories.

Construction of PLB HDPE pipe

The PLB HDPE pipe shall have two concentric layers viz. outer layer and inner layer. The outer layer shall be made of HDPE material and the inner layer of solid permanent lubricant. These concentric layers shall be co-extruded and distinctively visible in cross section under normal lighting conditions and generally conform to IS-9938. The colour of the PLB HDPE pipe shall be finalized during detail engineering. In the finished PLB HDPE pipe, the co-extruded inner layer of solid permanent lubricant shall be continuous and integral part with HDPE outer layer and preferably be white in colour. The inner layer of solid permanent lubricant shall not come out during storage, usage and throughout the life of the pipe. The pipe shall be supplied in a continuous length of 1000 (one thousand) meter in coil form, suitable for transportation, installation and handling purposes. The finished pipe shall be of good workmanship such that the pipe is free from blisters, shrink holes, flaking, chips, scratches, roughness, break and other defects. The pipe shall be smooth, clean and in round shape, without eccentricity. The ends shall be cleanly cut and shall be square with axis of the pipe.

General

The HDPE pipe shall conform to the following standard and the technical specifications described in the following sections.

a) IS: 4984 / IS: 2530/IS:14151/(part1)/ IS:9938/IS:7328/IS12235(Part-9)/IS:5175

b) ASTM D 1693/ ASTM D 638/ ASTM D 648/ ASTM D 790 / ASTM D 1712/ ASTM D 2240/ ASTM D 4565 / ASTM F 2160/ ASTM G 154

c) TEC-spec no. GR/CDS-08/02/NOV-04(including all amendments)-HDPE pipe for use as duct for optical fibre cable.

Material

The raw material used for the PLB HDPE pipe shall meet the following requirements:

(i) The anti-oxidant establishers, colour master batch and other additive used shall be physiologically harmless and shall be used only to minimum extent necessary to meet the specification.

(ii) Usage of any additives used separately or together, should not impair the long-term physical and chemical properties of the PLB HDPE pipe. Under Ground Fibre Optics- Technical Specification Page 13 of 32.

(iii) Suitable Ultra Violet stabilizers may be used for manufacture of the PLB HDPE pipe to protect against UV degradation when stored in open for a minimum period of 8 months.

(iv) The ash content of the colour master batch shall not be more than 12% when tested as per method detailed below:

Test Method for ash content: About one gram of the sample under test shall be taken and dried at 105°C for two hours in a platinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600±50°C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.

v) The base HDPE resin used for manufacturing outer layer of pipe shall conform to any grade of IS-7328 or to any equivalent standard meeting the following requirement when tested as per standards referred in this Section below.

a) Density (outer and inner layer): 940 to 958kg/m3 at 27°C. The density of completed PLB HDPE shall not be differ by more than 0.003gms/cc by this value when tested as per IS:2530 or IS:7328.

b) Melt Flow Rate (MFR): 0.2 to 1.1 g/10 minutes at 190°C & 5 kg load: when tested as per IS:2530. The MFR of the outer layer of the completed PLB HDPE pipe shall not differ by more than 30% of this value.

c) Tensile Strength at Yield: 20 N/mm2 minimum, when tested As per ASTM D 638,Type-IV specimens

d) Elongation at break: >600%, when tested as per ASTM D638, Type-IV specimens

e) Flexural Modulus at 1% strain: 690 N/mm^2 minimum, when tested as per ASTM D 790.

f) Hardness, Shore-D: Between 60 and 65 units, when tested as per ASTM D 2240

g) Heat Deflection Temperature at 45 g/mm2: 65ºC minimum, when tested as per ASTM D 648.

h) Environmental Stress Crack resistance, When tested with 10% Igepal, CO 0630 Solution 50ºC: 96 hrs., when tested as per ASTM D 1693, No cracks.

i) Weathering in artificial (UV) light (Specimens shall be as per ASTM D 638 Type- IV) and cut from compression moulded sheet. After exposure for 720 hrs., Tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength obtained at above.

j) OIT (in Aluminium Pan): 30 minutes minimum, when tested as per standard

k) UV Stabiliser Content: Hindered Amine Light Stabliser minimum 0.15%, when analysed as per FT-IR method.

vi) In the inner layer of PLB HDPE pipe, the friction reducing, polymeric material to be used as the inner layer lubrication material shall be integral with HDPE layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling.

Dimension of pipe

The nominal size of the pipe shall be minimum 40mm for OFC Cable and minimum 160mm for 132KV Cable and Thickness ,Pressure of the HDPE pipe will be depending as per the requirement of site Condition.

Accessories of PLB HDPE pipe

The following accessories are required for jointing the pipe and shall be supplied along with the pipe. The manufacturers shall provide complete design details, procedure for method of installation and type of the material used for the accessories. No part of the accessories shall contain metal part and minimum pulling force of the coupler shall be 330kgf. The accessories shall pass the ageing test at 70+2ºC and there shall be no leakage when tested for 168 hours.

i) Plastic coupler: The coupler shall be used to join two PLB HDPE pipes. The coupling shall be able to provide a durable airtight and watertight joint between two pipes without deteriorating the strength of the pipes. The strength of coupler shall match the primary strength of the PLB HDPE pipe and threaded coupler is not acceptable. The jointing shall meet the air pressure test of 15 kg/cm2 for a minimum period of 2 hours without any leakage.

ii) End plug: This shall be used for sealing the ends of empty pipe, prior to installation of FO cable and shall be fitted immediately after laying of the PLB HDPE pipe, to prevent entry of any unwanted elements such as dirt, water, moisture, insects/rodents etc.

iii) Cable sealing plug: This is used to hold the cable and prevent entry of any unwanted elements, as specified above.

iv) End cap: This cap is made of hard rubber, shall be fitted with both ends of PLB HDPE pipe to prevent the entry of any unwanted elements such as dirt, water, moisture, insects/rodents during transportation and storage.

v) Set of installation/maintenance accessories comprising of C-Spanners for tightening plastic coupler (4 nos.), Rotary duct cutter (2 nos.), spare cutting wheel (4 nos. Per Rotary Duct cutter), Chamferring tool for giving slight chamfer to the ends of PLB HDPE pipe shall be used during maintenance of the PLB HDPE pipes and these items (1set) shall be supplied along with the pipe.

Workmanship

The pipe shall be free of blisters, shrink holes, break and other defects. The PLB HDPE pipe ends shall be cut as square as possible to longitudinal aspects. The internal and external PLB HDPE pipe surfaces shall be smooth. The colour should be uniform throughout.

Marking

All the pipe, shall be clearly marked at intervals of 1 meters with the following data which is not less than 5 mm high. The details of marking on pipe shall be approved by Employer before commencement of manufacturing.

- Owner's Name with logo
- Manufacture's name or trade mark
- Year of manufacturing
- Type of PLB HDPE pipe and size
- Running length marking

Tests & Inspection: The general condition of testing & inspection is given in section-03 of technical specification.

Type Test

The PLB HDPE pipes & accessories offered to be supplied should have been type tested as per requirement specified in relevant TEC specification or equivalent standard. The Bidder shall enclose the previous type test report and/or type approval certificate from Telecom Engineering Centre (TEC), Department of Telecommunication, according to relevant TEC for the proposed PLB HDPE duct meeting the specified requirement.

Factory Acceptance Testing:

The following tests shall be carried out during Factory Acceptance Testing (FAT) in Table 2- 4.

4.3.68 Installation of Underground Fibre Optic Cable System

The Underground Fibre Optic Cable shall be installed along the power cable to be supplied & installed under this Project. This part of the section describes the installation procedures, installation of PLB HDPE pipes, installation of RCC hume pipes and GI Pipes, marking, backfilling, installation of underground FO cable, construction of manholes, splicing, termination and site acceptance testing requirements of the underground fibre optic cabling system.

4.3.69 Installation of PLB HDPE Pipe

One PLB HDPE pipe shall be laid at bottom of the trench after making the surface smooth and providing minimum 80 mm sieved, stone free sand bedding. After laying the pipe additional sieved sand shall be added to increase the height of the sand layer to a total of 200 mm hence positioning the PLB HDPE pipe in the middle of the layer. Other important steps are described as under:

a. PLB HDPE Pipe shall be laid in a flat bottom trench free from stones, sharp edged debris.

b. The Pipe shall be placed in trenches as straight as possible. Minimum bending radius of pipe and fibre optic cable shall always to be taken into account.

c. The ends of pipes shall always be closed with end plugs to avoid ingress of mud, water or dust i.e. all pipe opening shall be sealed to avoid entry of foreign material.

d. The pipes shall be joined tightly & properly through plastic couplers and the joint shall be smooth and free from steps. The joints shall be made properly so that it passes the duct integrity test specified in this section. All joints shall be assembled with proper tools only.

e. Coupler shall not be placed along the bend portion of the pipe

f. Cable sealing plugs shall be provided at all manhole locations and at locations cable is coming out of the pipe and empty pipe ends i.e. all pipe openings shall be sealed to avoid entry of foreign objects.

g. PLB HDPE pipes shall be installed in a manner that fibre optic cable can be pulled, blown, de-blown without damaging the fibre optic cable due to stresses. The Contractor shall all joints inspected before carrying out the backfilling, by a representative of Owner/Employer. Joints shall be visually inspected and checked for tightness.

4.3.70 Reinstatement

The contractor shall be required to carry out reinstatement of the excavated area. Reinstatement shall include all works necessary (such as reconstruction of metalled/asphalt road, footpath etc) to restore the excavated area to original quality and shape. Temporary reinstatement of footpath stipulated in this section shall be carried out as a part of backfilling. The Contractor shall be responsible for carrying out complete reinstatement work irrespective of area or type of reinstatement without any additional cost implication to Employer.

4.3.71 Installation of GI Pipe

The GI pipe of nominal bore of minimum 100 mm shall be laid wherever road crossings, bridge crossings, railway crossings are encountered on the route as well as on wall/floor crossings in a building. PLB HDPE pipe shall be inserted into GI pipe. Whenever it is not possible to install the FO cable underground due to non availability of the right of way or any other unavoidable reasons, the HDPE ducts along with FO cable shall be installed in GI pipe on the wall inside the sewerage pipe and or on the existing rock/concrete/brick wall/surface with suitable fixing arrangement and concreting, if necessary, with specific approval of the Employer in case to case basis. The GI pipe shall conform to at least medium class and conform to IS: 1239 (Part – I). In regard to bridge and culvert crossing, GI pipe may be installed by concreting the GI pipe along the bridge or by using supporting brackets or by laying underneath the existing footpath etc. The PLB HDPE pipes shall be installed through this GI pipe. Wherever underground fibre optic cable is required to be spliced to overhead fibre optic cable using the outdoor Joint Boxes installed on towers, GI pipes shall be used to protect the portion of the cable/duct upto a height of about 6 to 10 meters and shall be extended in the ground up to suitable depth of the trench so that minimum bending radius of the cable is maintained. The GI pipe shall be properly clamped/ fixed on the tower leg. The Contractor shall supply and install all necessary accessories as part of the installation work. The Contractor shall propose the exact methods and procedures for implementation of crossings taking into consideration the following guidelines, for approval by the Employer:

- The GI pipe shall be extended at least 5 meters on each side of crossing subject to availability of space and approval of the Employer.
- Two GI pipes shall be joined using proper tools, sockets and accessories etc.
- Proper arrangements shall be made to seal the ends of GI pipe after installation of PLB HDPE pipes.
- Minimum bending radius of optical fibre cable shall always be taken into consideration.
- 1:2:4 concrete shall be used for encasing of the GI pipe, wherever required.
- The floor of the trench shall be levelled by laying at least 50 mm of soft soil or sieved sand before installing the GI pipe.
- The GI pipes shall be supplied in standard lengths of 6m or as approved by Employer.
- The GI pipe shall be sealed at both ends.
- The GI pipe of suitable length shall be provided at road crossings, bridge crossings, railway crossings encountered on the route as well as on wall/floor crossings in a building and also for protection of fibre optic cable at tower/pole mounted joint boxes.

4.3.72 Underground Fibre Optic Cable Installation

The cable shall be installed inside the 40mm diameter PLB HDPE pipe installed under this package along the route(s). Generally the cable shall be installed by compressed air blowing technique. However, for spans upto 150 meter, the Contractor can use pulling method for installation of OFC in HDPE pipe. If any temporary manhole or hand hole is required for installation of OFC, the same will be done by the Contractor without any additional cost implication. Adopting pulling method for installation of OFC for spans more than 150 meter, shall be subjected to approval of the Employer and shall be substantiated by proper justification. Contractor shall take into consideration the following guidelines, for installation of OFC approval by the Employer.

- The Optical Fibre Cable Drums shall be handled with utmost care. The drum shall not be subjected to shocks by dropping etc. They shall not be normally rolled along the ground for long distance and when rolled, shall in the direction indicated by the arrow. The battens shall be removed only at the time of actual laying.
- A blowing machine in association with an appropriate compressor shall be used for blowing.
- Temporary blowing chambers (if required) shall be constructed and then backfilled after blowing operation is completed.
- Locations along the route, which provide easy access points for blowing machine and compressor, shall be determined.
- Before starting the cable blowing, PLB HDPE pipe shall be checked for obstacles or damage. Checking shall be done by using a proper sized mandrel.
- Always blow downhill wherever possible.
- Multiple blowing machines may be used in tandem if so required.
- Care must be taken not to violate the minimum bending radius applicable for the fibre optic cable. Tension in the cable during laying shall not exceed tension limit of the OFC. Installation by pulling may be permitted by the Employer only in specific cases where installation by blowing is not feasible on specific approval from the Employer. In case pulling is used, the pulling speed shall be determined considering the site condition. While installing the cable, excess length of about 10 meters shall be stored at each joint location for each side. Excess length of 10 m shall be kept at one ends of a road crossing culvert crossing and 20 meters at one end of bridges. However, exact excess lengths and manhole locations shall be finalised during detailed engineering depending upon the site requirement.

4.3.73 Trenchless Digging

It is envisaged that trenchless digging shall be used in short section for crossing National highways, important road or rail crossings etc. Trenchless digging shall be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of HDPE pipe.

Contractor's Scope of Work for Trenchless Digging

The Contractor's scope of work under this contract shall include, but shall not be limited to, the following:

- Identify, provide and transport all equipment to the locations along the route as per the requirement to install PLB HDPE pipe by trenchless digging method.
- Excavation and backfilling of entry and exit pits.
- Detection and protection of existing underground facilities of other utilities along the route.
- Installation of 40 mm PLB HDPE pipe along the specified route by trenchless digging method and joining of PLB HDPE pipe by plastic coupler and sealing of PLB HDPE pipe at both ends by end plugs.
- Installation of manholes, termination of PLB HDPE pipes into the manholes and sealing of PLB HDPE pipes at the manhole entry as per approved drawings.
- Providing all plants, tools and tackles, consumables, marking and fencing required for the execution of the work as per the best engineering and safety practices.

- Maintain all lights, guards, plates, safety measures, sign boards etc. When and where necessary and/or required by the Owner/Employer or by any other statutory authority for the protection of works and/or for the safety and convenience of the public or the workers at the installation sites.
- Arrange electricity by arrangement of generators or other means at the site wherever required.
- Arrange construction water at the sites.
- Intimation to road maintenance agency, traffic police, other concerned utilities as necessary.
- Testing and inspection of installed PLB HDPE pipes and manholes.
- Rectifications, re-digging and re-installation of PLB HDPE pipes in case of problem during testing and fibre optic cable blowing/pulling.

As Built Drawings/details

The Contractor shall submit the as built drawings for the whole route indicating the route, depth of digging and manhole locations for easy maintenance of the installed system.

List of Drawings/documents required to be submitted for Employer's Approval

The Contractor shall ensure that the required drawings and documents are submitted well in time to avoid any delay in approval and project execution. The following minimum drawings and documents are required to be submitted by the Contractor for approval of the Employer:

- The methods/procedures and the equipment/machines to be used for different types of trenchless digging techniques
- Bill of quantities for various items as per contract
- SAT Reports
- As built drawings

4.3.74 Site Acceptance Testing (SAT)

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment/material for SAT shall be called Pre-SAT activities. During installation the Contractor shall maintain proper record of measurements in approved format and shall be given to the Owner/Employer (along with As Built drawing of the routes) for cross checking during SAT.

SAT for Excavation, Backfilling, Installation of Pipes, Manholes.

The tests shall include but shall not be limited to the following:

- Depth Check: One sample every 200 mtrs, Contractor shall prepare a sample pit at a location identified by the Employer. Depth of each item, warning tape, no. Of warning bricks (if applicable), pipes, cable etc. Shall be measured. Depth shall be as per technical specifications and shall correspond to recorded measurements.

- Crossings: 10% of each type, visual inspection for checking conformance with drawings, thickness of Concrete, RCC Hume Pipe and GI pipe.
- Manholes: As per technical specifications.

After inspection the Contractor shall backfill and carry out other restoration work at no additional cost to the Owner/Employer.

SAT for Underground Fibre Optic Cable

SAT for optical fibre cable shall be carried out link by link. Prior to installation, every fibre optic cable segment shall be tested for continuity and attenuation and measurements shall be recorded. Test requirements are as per table 2-7. Any discontinuity or attenuation beyond permissible limits in any of the fibres has to be recorded and brought to the notice of Employer. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Test requirements are indicated in table 2-9 and in no case losses attributed due to other factors viz. Extra splice, kinks, will be acceptable to the limit determine by the following formula:

Max attenuation @ 1550 nm: 0.21dB/km + 0.05dB x total no of splices + 0.5dB x connector

Max attenuation @ 1310nm: 0.35dB/km + 0.05dB x total no of Splices + 0.5dB x connector

Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable failure during installation. The Contractor shall have to either replace the concerned cable span at its own cost or provide additional splicing, joint box and manholes required to rectify the fault at its own cost. The fibre attenuation shall be tested again after replacement or rectification of fault. In case it is found that the splices are bad (loss is unacceptable as per approved test procedures), the Contractor shall have to do re-splicing and provide new Joint Box wherever required at no additional cost to the Owner/Employer. After re-splicing the end-to-end testing shall be repeated. The splice testing requirements are indicated in table below.

Table 6: Fibre Optic Cable Pre-Installation Testing

Item	Description
1	Physical Inspection of the cable assembly for damage
2	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm

Table 7 : Fibre Optic Cable Splice Testing

Item	Description
1	Per splice attenuation with OTDR (bi-directional average) at 1550 nm
2	Physical inspection of Joint Box for proper fibre routing techniques
3	Physical inspection of sealing techniques, weatherproofing, etc

Table 8: Fibre Optic Cable Commissioning Testing

Item	Description
1	Fibre continuity and link attenuation (bi-directional) for each fibre at 1310 &1550 nm by OTDR
2	Fibre continuity and link attenuation (bi-directional) for each fibre at 1310 &1550 nm by Power Meter & Laser Source
3	Average splice loss (bi-directional) for each splices and average splice loss for the link by OTDR at 1550 nm.

SAT for PLB HDPE pipe

For PLB HDPE pipes, duct integrity tests shall be carried out as described below. The **Duct cleaning (Sponge test)** test shall be carried out on all the ducts before blowing/pulling of the cable between two consecutive manholes on the PLB HDPE pipes.

Duct cleaning (Sponge test)- Compressed air should be blown through the PLB HDPE pipe in order to remove dirt and water, if any, with the help of suitable Air Compressor. A short blast of air about 2-3 Bar shall be blown through the PLB HDPE pipe for about 2 minutes. Sponge shall be blown through the duct to thoroughly clean the duct from inside.

Crush and deformity test

Place a shuttle of length <15cm and O.D. 80% of the inner diameter of the offered PLB HDPE pipe. Connect the compressor pipe with a suitable flexible wire grip at the other end to catch the shuttle and start blowing operation to the pipe and check if shuttle reaches at the other end. If shuttle gets stuck the Contractor shall adopt suitable arrangement at site to locate the deformity/damage in the HDPE pipe, repair the pipe and ensure end-to-end continuity of the duct in sound condition.

4.3.75 Documentation

Apart from survey reports as mentioned above, the Contractor will submit the following documents after completion of the job and acceptance by the Employer:

- As built drawing of the route indicating the distance from road centre, OFC drum length, location of other utilities, link Q, OFC loop length, name of the road, sections and positions of PLB HDPE pipes, couplers, warning bricks/stone, manholes, G.I. pipes, RCC pipes, joint box, conduits, bends, trays, optical fibre cable loop lengths in manholes etc.
- Depth of PLB HDPE pipe in various sections of the route executed through open trenching.
- Sections of trenching digging executed through various methods.
- Specific deviation w.r.t. the installation and supply items, if any, from the technical specification. If there is no deviation, either explicit or implicit, the Contractor will provide a certification to this effect.

- Without submission of the above documentations, the Site Acceptance Testing of various items as described above will be deemed to be incomplete.

4.3.76 Miscellaneous Jobs

In order to provide end-to-end connectivity, it may be required to execute some miscellaneous jobs as detailed below.

Routing of Cables inside building.

In order to route the OFC (Optical Fibre Cable) from the underground trench to the control room building it is necessary to install the cable on walls inside PLB HDPE pipe over the existing cable tray/raceways inside the building.

Installation of PLB HDPE pipe on wall

The PLB HDPE pipe may be required to be installed on the wall using steel or G.I clamps. The contractor will provide the required clamps and other consumables sufficient for such installation. The contractor will take care of aesthetics while installation. The OFC will be pulled through the PLB HDPE pipe with due care as described in relevant Para of this specification.

4.3.77 INSPECTION & TESTING Type Testing

Bidder shall offer the type tested product meeting the requirement of technical specifications.

Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Visual inspection shall be carried out on 100% basis for all the equipment/items offered. Factory acceptance testing shall be carried out on Underground fibre optic cable, Joint box, PLB HDPE pipe etc.

4.3.78 System Maintenance

The one year period commencing immediately after the operational acceptance is called the Defect liability Period/warranty period. Operational Acceptance shall be given on successful completion of SAT. During this period, the Contractor shall replace or repair all defective parts. The one year period commencing immediately after the operational acceptance is called the Warrantee Period/Defect Liability Period. During the Warranty Period/Defect Liability Period, the Contractor shall guarantee that there shall be minimum outage of the supplied system. During this period, the Contractor shall replace or repair all defective parts and shall have prime responsibility for maintaining an operational system.

4.3.79 Documentation

The documentation provided shall include the following:

- Detailed list of the deliverables
- Description of the products
- Technical particulars
- Installation manuals
- Maintenance manuals
- Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality

SPECIFIC TECHNICAL PARTICULARS FOR 33 KV XLPE CABLE

Sl.No.	Particulars	Details
1	Description of Cable	ARMOURING: ARMOURED CORE MATERIAL: COPPER INSULATION: XLPE NOMINAL AREA: 400 SQ.MM. NO.OF CORE: Single Core SHEATHING MATERIAL: EXTRUDED PVC, INNER & OUTER VOLTAGE GRADE: 33KV
2	Highest system voltage	36 KV
3	Voltage Grade	19/ 33KV
4	Earthing System	Effectively earthed
5	Frequency	50 Hz
6	Size of Cable	400 sqmm
	No. of Core	1C
7	Rated Power Frequency Withstand Voltage (1 min)	70 KV (rms)
8	Impulse withstand BIL (1.2/ 50/ micro Sec) Line to earth	±170 kVp
9	Rated short time withstand current	31.5 KA (rms) for 3 sec
10	Rated peak withstand current (1 sec)	78.75 KA
11	No of phase per Ckt	3
12	Maxm.Conductor temp	90 degree C at maxm. continuous current
13	Maxm. Permissible short circuit Temperature	250 degree C for one second
14	End Sealing	H.S. Caps
15	**CABLE DETAILS : CONDUCTORS**	
i	Conductor material	Plain un-tinned annealed copper
ii	Conductor Shape	Compacted circular.

Sl.No.	Particulars	Details
iii	Conductor Screen	Extruded, Cross-linked, semi conducting compound of suitable thickness. Semi conducting separator tapes with 50% overlap to be applied between conductor and conductor screen.
iv	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16	**INSULATION**	
i	Insulation material	XLPE
ii	Insulation thickness	8.8 mm (Nominal thickness)
iii	specifiedinsulation resistance at 90^0C	$1x10^{12}$ ohm cm
iv	Insulation Screen: Type & Material	Freely strippable (with heat) type extruded non-metallic semi conducting compound followed by copper metallic tape with minimum 25 % overlapping.
16	Resistivity of the semiconducting compound	Max 500 Ohm-meter
17	Longitudinal water barrier Material	Layer of semiconducting tape with suitable water swellable absorbent with 50% overlap.
18	Overall sheath	Extruded black HDPE (TypeST7) with anti termite and anti rodent treatment.
19	Coating of outer sheath	A hard baked layer of graphite or semi conducting layer shall be applied over the outer sheath as outer electrode for testing the sheath.
	Armouring	Armoured
20	**TESTS**	
i	Type Test	All tests as per specifications IEC Standards.
ii	Routine Test	All tests as per specifications IEC Standards.
iii	Acceptance Test	All tests as per specifications IEC Standards.

Sl.No.	Particulars	Details
iv	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
21	Bending Radius	The minimum bending radius of XLPE insulated cables as follows: Cable: Bending radius Single Core: 25xD D – diameter of overall conductor.

SPECIFIC TECHNICAL PARTICULARS FOR 132 KV & 220KV XLPE CABLE

Sl.No.	ITEMS	PARTICULARS
1	Description of Cable	Stranded single core compacted copper core screening by a layer of semi conducting tape followed by a layer of semiconducting compound as conductor screen, XLPE insulation, insulation screening with semiconducting compound extruded directly over the insulation, (semiconducting conductor screen, XLPE insulation, semiconducting insulation screen-all in one triple extrusion process), longitudinal sealing by a layer of water swellable semiconducting non woven tape over insulation screen, followed by radial sealing (**metal sheath of Corrugated Aluminum**),and overall extruded black HDPE Sheathed (TypeST7)
2	Highest system voltage	145KV 245KV
3	Voltage Grade	76/132KV 127/220KV
4	Voltage variation	+10% and -12.5%
5	Frequency	50 Hz
6	Frequency variation	±3%
7	Power frequency withstand voltage	190 KV rms for 30 minutes 318KV for 30 minutes
8	Lightning impulse withstand voltage	±650KVpeak 1050peak
10	No of phase per Ckt	3
11	Earthing system	Effectively earthed

Sl.No.	ITEMS	PARTICULARS
12	Size of Cable	**400/ 630/ 800sq.mm**
13	Max. in Conductor Temp.	90ºC at maximum continuous current.
14	Fault level	40KAfor3second 50KAfor3second (considering parallel path of lead sheath and screen copper for metallic screen)
15	Maximum permissible Temperature (short Ckt)	250ºC for one second.
16	**CABLE DETAILS : CONDUCTORS**	
16.1	Conductor material	Plain un-tinned annealed copper.
16.2	Conductor Shape	Compacted circular.
16.3	Conductor Screen	Extruded, Cross-linked, semi conducting compound of suitable thickness. Semi conducting separator tapes with 50% overlap to be applied between conductor and conductor screen.
16.4	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16.5	Insulation	
	a)material	XLPE
	b)specified insulation resistance at 90^{0}C	1x10^{12} ohm cm
16.6	Insulation Screen: Type & Material	Extruded semi conducting compound.
16.7	Resistivity of the semiconducting compound	Max 500 Ohm-meter
16.8	Longitudinal water barrier Material	Layer of semiconducting tape with suitable water swellable absorbent with 50% overlap.
16.9	Radial moisture barrier Material	Seamless or seam welded Corrugated Aluminum sheath with anti-corrosive material.
16.10	Overall sheath	Extruded black HDPE (TypeST7) with anti termite and anti rodent treatment.
16.11	Coating of outer sheath	A hard baked layer of graphite or semi conducting layer shall be applied over the outer sheath as outer electrode for testing the sheath.

Sl.No.	ITEMS	PARTICULARS
17.	Approximate Length of cable in a drum	500 metres with a tolerance range of ±5% or as per requirement.
18	Bending Radius	The minimum bending radius of XLPE insulated cables as follows: Cable: Bending radius Single Core: 25xD D – diameter of overall conductor.
19	**TESTS** Applicable standards	IEC60840 IEC62067
19.1	Type Test a) whether previous test reports will be sufficient b) whether sample to be Type tested against this order.	All tests as per specifications IEC Standards Yes, if done on identical cable. No, if done on identical cable.
19.2	Routine Test	All tests as per specifications IEC Standards.
19.3	Acceptance Test	All tests as per specifications IEC Standards.
19.4	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
20	**INSTALLATION, TERMINATION AND JOINTS**	
21	Ambient temperature Ground temperature Thermal resistivity of soil	45^0C 30^0C 150^0C cm/Km
22	Laying Configuration	Trefoil formation.
23	Depth	1.5 m below ground level.
24	Termination	
25	Type	**AS per requirement**
26	Joints Required	**No**

Sl.No.	ITEMS	PARTICULARS
27	Earth Link Boxes Required	**Yes. In both end and at joints as per cable bonding system**
28	Surge Suppressor Required	**Yes**
29	Type Bonding '	**Single end bonding/ cross bonding**

SPECIFICATION OF CABLE TRAY

1) Width of cable tray: 600mm/300mm.

2) Depth of cable tray: 75mm

3) Length of cable tray: 2.5 metres

4) Thickness of cable tray: 3mm

5) Insert plates shall be put at every 750mm

6) Cable tray type shall be perforated type.

7) Cable trays shall be pre- galvanized

TECHNICAL SPECIFICATION OF OUTDOOR CURRENT AND POTENTIAL TRANSFORMERS

4.4.1 SCOPE OF CONTRACT

4.4.1.1 This Section of the Specification covers general requirements for design, engineering, manufacture, assembly and testing at manufacturer's works of 33 kV outdoor Current and Potential Transformers.

4.4.2 STANDARDS

4.4.2.1 The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory authorities.

4.4.2.2 In case of any conflict between the Standards and this specification, this specification shall govern.

4.4.2.3 The current transformer shall comply also with the latest issue of the following Indian standard.

(i) IS: 2705(Part-I) Current transformers: General requirement.

(ii) IS: 2705(Part-II) Current transformers : Measuring Current transformers

(iii) IS: 2705(Part-III) Current transformers : Protective Current transformers

(iv) IS: 2705(Part-IV) Current transformers: Protective Current transformers for special purpose application.

(v) IS: 3156(Part-I) Potential transformers: General requirement.

(vi) IS: 3156 (Part-II) Potential transformers : Measuring Potential transformers

(vii) IS: 3156 (Part-III) Potential transformers : Protective Potential transformers

4.4.3 GENERAL REQUIREMENTS

4.4.3.1 The cores of the instrument transformers shall be of high grade, non-aging CRC steel of low hysteresis loss and high permeability.

4.4.3.2 Instrument transformers shall be of Dead Tank design or Live Tank design.

4.4.3.3 The instrument transformers shall be truly hermetically sealed to completely prevent the oil inside the tank coming into contact with the outside temperature. To take care of oil volume variation the tenderer are requested to quote the current transformers with stainless steel diaphragm (bellow).

4.4.3.4 The instrument transformers shall be completely filled with oil.

4.4.3.5 A complete leak proof secondary terminal arrangement shall be provided with each instrument transformers, secondary terminal shall be brought into weather, dust and vermin proof terminal box. Secondary terminal boxes shall be provided with facilities for easy earthing, shorting, insulating and testing of secondary circuits. The terminal boxes shall be suitable for connection of control cable gland.

4.4.3.6 All instrument transformers shall be of single phase unit.

4.4.3.7 The instrument transformers shall be so designed to withstand the effects of temperature, wind load, short circuit conditions and other adverse conditions.

4.4.3.8 All similar parts, particularly removable ones, shall be interchangeable with one another.

4.4.3.9 All cable ferrules, lugs, tags, etc. required for identification and cabling shall be supplied complete for speedy erection and commissioning as per approved schematics.

4.4.3.10 The instrument transformers shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics.

4.4.3.11 All steel work shall be degreased, pickled and phosphated and then applied with two coats of Zinc Chromate primer and two coats of finishing synthetic enamel paint.

4.4.4 INSULATING OIL

4.4.4.1 The quantity of insulating oil for instrument transformers and complete specification of oil shall be stated in the tender. The insulating oil shall conform to the requirement of latest edition of IS: 335

4.4.5 COMMON MARSHALLING BOXES

4.4.5.1 The outdoor type common marshalling boxes shall conform to the latest edition of IS 5039 and other general requirements specified hereunder.

4.4.5.2 The common marshalling boxes shall be suitable for mounting on the steel mounting structures of the instrument transformers.

4.4.5.3 One common marshalling box shall be supplied with each set of instrument transformers. The marshalling box shall be made of sheet steel and weather proof. The thickness of sheet steel used shall be not less than 3.0 mm. It is intended to bring all the secondary terminals to the common marshalling.

4.4.5.4 The enclosures of the common marshalling boxes shall provide a degree of protection of not less than IP 55 (As per IS 2147).

4.4.5.5 The common marshalling boxes shall be provided with double hinged front doors with pad locking arrangement. All doors and removable covers and plates shall be sealed all around with neoprene gaskets or similar arrangement.

4.4.5.6 Each marshalling box shall be fitted with terminal blocks made out of moulded non-inflammable plastic materials and having adequate number of terminals with binding screws washers etc. Secondary terminals of the instrument transformers shall be connected to the respective common marshalling boxes. All out going terminals of each instrument transformer shall terminate on the terminal blocks of the common marshalling boxes. The terminal blocks shall be arranged to provide maximum accessibility to all conductor terminals.

4.4.5.7 Each terminal shall be suitably marked with identification numbers. Not more than two wires shall be connected to any one terminal. ***At least 20 % spare terminals shall be provided over and above the required number***.

4.4.5.8 All terminal strips shall be of isolating type terminals and they will be of minimum 10 A continuous current rating.

4.4.5.9 All cable entries shall be from bottom. Suitable removable gland plate shall be provided on the box for this purpose. Necessary number of cable glands shall be supplied fitted on to this gland plate. Cable glands shall be screw on type and made of brass.

4.4.5.10 Each common marshalling box shall be provided with two numbers of earthing terminals of galvanised bolt and nut type.

4.4.5.11 All steel, inside and outside work shall be degreased, pickled and phosphate and then applied with two coats of Zinc Chromate primer and two coats of finishing synthetic enamel paint. The colour of finishing paint shall be as follows: -

i) Inside: Glossy White

ii) Outside: Light Grey (Shade No. 697 of IS: 5)

4.4.6 BUSHINGS AND INSULATORS

4.4.6.1 Bushings and Insulators shall be of Porcelain, Solid core type. Porcelain used for the manufacture of bushings and insulators shall be homogeneous, free from defects, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

4.4.6.2 Glazing of the porcelain shall be of uniform brown colour, free from blisters, burns and other similar defects. Bushings shall be designed to have sufficient mechanical strength and rigidity for the conditions under which they will be used. All bushings of identical ratings shall be interchangeable.

4.4.6.3 Puncture strength of bushings shall be greater than the dry flashover value. When operating at normal 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 bushings when operating at the normal rated voltage.

4.4.6.4 The design of bushing shall be such that the complete bushing is a self-contained unit and no audible discharge shall be detected at a voltage up to a working voltage (Phase Voltage) plus 10%. The minimum creepage distance for severely polluted atmosphere shall be 25 mm/KV.

4.4.6.5 Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.5 g in horizontal direction and 0.6g in vertical direction.

4.4.6.6 Bushings shall satisfactorily withstand the insulation level specified in data sheet.

4.4.7 TESTS

2.4.1.1 Routine/Acceptance Tests (all units)

2.4.1.2 **A**ll routine tests shall be carried out in accordance with relevant Standards. All routine/acceptance tests shall be witnessed by the Purchaser/his authorised representative.

2.4.1.3 **Type Tests:** The bidder shall furnish type test certificates and results for the all tests as per relevant Standards along with the bid for current and potential transformers of identical design.

2.4.1.4 Type test certificates so furnished shall not be older than 7 (seven) years as on date of Bid opening.

4.4.8 NAME PLATES

4.4.8.1 All equipment shall have non-corrosive name plates fix at a suitable position indelibly mark with full particular there on in accordance with the standard adapted.

4.4.9 MOUNTING STRUCTURES

4.4.9.1 All the equipment covered under this specification shall be suitable for mounting on steel structures.

4.4.9.2 Supply of mounting structures is also in the scope of this tender.

4.4.9.3 Each equipment shall be furnished complete with base plates, clamps, and washers etc. and other hardware ready for mounting on existing steel structures.

4.4.10 SAFETY EARTHING

2.4.10.1. The non-current carrying metallic parts and equipment shall be connected to station earthing grid. For this two terminals suitable for 40mm X 10mm GI strip shall be provided on each equipment.

4.4.11 TERMINAL CONNECTORS

4.4.11.1 The equipment shall be supplied with required number of terminal connectors of approved type suitable for ACSR. The type of terminal connector, size of connector, material, and type of installation shall be approved by the Purchaser, as per installation requirement while approving the equipment drawings.

4.4.12 TECHNICAL DATA SHEET FOR CURRENT AND POTENTIALTRANSFORMERS

4.4.12.1 For 132 & 33 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 up to the terminal blocks.

4.4.12.2 TYPE AND RATING:

All instrument transformer shall be outdoor type, single phase, oil immersed, self-cooled suitable for mounting on steel structure. The instrument transformer shall have the following ratings and particulars.

Item	**Ratings and Particulars**	
(A) Nominal system voltage	**132kV**	**33 kV**
(B) Highest system voltage, kV	145	36
(C) Rated frequency, HZ	50	50
(D) System earthing	Solidly earth	Solidly earth
(E) Insulation level		
(a) Impulse withstand voltage: kVp	550	170
(b) One-minute p.f. Withstand voltage, kV (r.m.s.)	230	70
(F) Short time current for one second, kA	31.5	20
(G) Minimum creepage distance, mm	As per ISS	As per ISS
(H) Temperature rise		
(I) Feeder/ BYPASS/ Bus Coupler CT		
(i) No. of Cores	3	2
(ii) Transformation Ratio	As per schedule of requirement	
(iii)Rated Output		
(a) Core-1	30 VA	30 VA
(b) Core-2	15 VA	15 VA
(c) Core-3		N.A
(iv) Accuracy Class		
(a) Core-1	0.2	0.2
(b) Core-2	5P	5P
(c) Core-3	PS	N.A
(v) Accuracy Limit Factor		
(a) Core-1	--	-
(b) Core-2	10	10
(c) Core-3	-	-
(vi) Instrument security factor		
(a) Core-1	<5	<5
(b) Core-2	-	-
(c) Core-3	-	-

Item	**Ratings and Particulars**	
(vii) Minimum Knee point voltage, Volts		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3	1200	-
(viii) Maximum secondary resistance, ohm		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3	3	N.A
(ix) Maximum exciting current, at Vk/4 mA		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3 (at Vk/4)	30	N.A
(J) Transformer CT		
(i) No. of Cores	3	2
(ii) Transformation Ratio	As per schedule of requirement	
(iii)Rated Output	3	3
(b) Core-1	30 VA	30 VA
(b) Core-2	15 VA	15 VA
(c) Core-3	-	-
(iv) Accuracy Class		
(a) Core-1	0.2	0.2
(b) Core-2	5P	5P
(c) Core-3	PS	PS
(v) Accuracy Limit Factor		
(a) Core-1	--	-
(b) Core-2	10	10
(c) Core-3	-	-
(vi) Instrument security factor		
(a) Core-1	<5	<5
(b) Core-2	-	-
(c) Core-3	-	-
(vii) Minimum Knee point voltage, Volts		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3	1200	600
(viii) Maximum secondary resistance, ohm		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3	3	3
(ix) Maximum exciting current, at Vk/4 mA		
(a) Core-1	-	-
(b) Core-2	-	-
(c) Core-3 (at Vk/4)	30	15
POTENTIAL TRANSFORMER		
(i) No. of secondary windings		2
(ii) Transformation ratio		

Item		Ratings and Particulars	
(a)	Winding I	132kV/√3	33kV/√3
(b)	Winding II	/ 110V/√3	/ 110V/√3
(iii) Rated out put			
(a) Winding I		500	200
(b) Winding II		200	100
(vi) Accuracy class			
(a) Winding I		0.2	0.2
(b) Winding II		3P	3P
(v) Rated voltage factor		1.2	1.2

Note: It is intended to use different ratios of the same CT at the same time for various protections and metering cores. The CTS should therefore be suitable for the above purpose by secondary tapings only. The ratio change by secondary taps is acceptable as long as the required CT specifications are achieved at all ratios.

(i) The knee point voltage specified above shall be at higher ratio/ taps.

4.5.0 TECHNICAL SPECIFICATION OF ISOLATORS

4.5.1 SCOPE

4.5.1.1 This section of the specification is intended to cover design specifications for manufacture and testing of 132kV and 33 KV gang operated Isolators with all fittings and accessories.

4.5.1.2 The Isolators are for outdoor installation suitable for horizontally mounting on mounting structures and for use at sub-stations.

4.5.1.3 Isolators shall be supplied with Earth Switch as and where specified.

4.5.1.4 The bidder shall offer ac motor operated Isolators and earth switches.

4.5.2 GENERAL

4.5.2.1 The Isolators and accessories shall conform in general to IS 9921 (or IEC: 62271-102) except to the extent explicitly modified in specification.

4.5.2.2 All isolating switches and earthing switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 90□ angle from closed position to fully open position.

4.5.2.3 Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following:

(i). Isolator assembled with complete base frame, linkages, operating mechanism, control cabinet, interlocks etc.

(ii). All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

(iii) The isolator shall be designed for use in the geographic and meteorological conditions as given in Section 1.

4.5.3 DUTY REQUIREMENTS

4.5.3.1 Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

4.5.3.2 The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

4.5.3.3 In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated elsewhere in this specification.

4.5.3.4 The earthing switches shall be capable of discharging trapped charges of the associated lines.

4.5.3.5 The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make/break operation.

4.5.3.6 The isolator shall be capable of making/breaking magnetising current of 0.7A at 0.15 power factor and capacitive current of 0.7A at 0.15 power factor at rated voltage.

4.5.4 CONSTRUCTIONAL DETAILS

4.5.4.1 All isolating switches and earthing switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 90□ angle from closed position to fully open position.

4.5.4.2 **Contacts:**

4.5.4.3 The contacts shall be self-aligning and self-cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.

4.5.4.4 No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.

4.5.4.5 Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.

4.5.4.6 The moving contact of double break isolator shall have turn-and -twist type or other suitable type of locking arrangement to ensure adequate contact pressure.

4.5.4.7 **Blades:**

4.5.4.8 All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.

4.5.4.9 The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Corona shields/rings etc., shall be made up of aluminium/aluminium alloy.

4.5.4.10 Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

4.5.4.11 The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

4.5.4.12 **Insulators:**

4.5.4.13 The insulator shall conform to IS: 2544 and/or IEC-60168. The insulators shall have a minimum cantilever strength of 600/400 Kg. for 145/33 kV insulators respectively.

4.5.4.14 Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

4.5.4.15 **Base:**

Each isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure.

4.5.5 EARTHING SWITCHES

4.5.5.1 Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts.

4.5.5.2 The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

4.5.5.3 The earthing switches shall be constructionally interlocked with the isolator so that the earthing switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks.

4.5.5.4 Suitable mechanical arrangement shall be provided for de-linking electrical drive for mechanical operation.

4.5.5.5 Each earth switch shall be provided with flexible copper/aluminium braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The transfer of fault current through swivel connection will not be accepted.

4.5.5.6 The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat.

4.5.5.7 Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

4.5.5.8 The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

4.5.6 OPERATING MECHANISM

4.5.6.1 The bidder shall offer motor operated Isolators and earth switches. Earth Switches of 36 kV shall only be manual operated.

4.5.6.2 Control cabinet/operating mechanism box shall be made of aluminium sheet of adequate thickness (minimum 3 mm).

4.5.6.3 A “Local/Remote” selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.

4.5.6.4 Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

4.5.6.5 Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

4.5.6.6 Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.

4.5.6.7 Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non-operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting.

4.5.7 OPERATION

4.5.7.1 The main Isolator and earth switches shall be gang operated.

4.5.7.2 The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth switches shall be provided with "over center" device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

4.5.7.3 Each isolator and earth switch shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. Detachable type manual operating handle shall be provided. Suitable provision shall be made inside the operating mechanism box for parking the detached handles. The provision of manual operation shall be located at a height of 1000 mm from the base of isolator support structure.

4.5.7.4 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsion and bending stresses due to operation of the isolator. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/ pipes shall be provided with suitable universal couplings to account for any angular misalignment.

4.5.7.5 All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.

4.5.7.6 Signalling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signalling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

4.5.7.7 The position of movable contact system (main blades) of each of the Isolators and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earthing switch. The indicator shall be of metal and shall be visible from operating level.

4.5.7.8 The Supplier shall furnish the following details along with quality norms, during detailed engineering stage.

(i) Current transfer arrangement from main blades of isolator along with milivolt drop immediately across transfer point.

(ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator along with stoppers to prevent over travel.

4.5.8 TEST AND INSPECTION

4.5.8.1 The switches shall be subjected to the following type test in accordance to with IS: 9920.

i. Dielectric test (impulse and one minute) power frequency withstands voltage.
ii. Temperature rise test
iii. Rated off load breaking current capacity
iv. Rated active load breaking capacity

v.Rated line charging breaking capacity
vi.Rated short time current
vii.Rated peak withstand current
viii.Mechanical and Electrical Endurance

4.5.8.2 The equipment shall be subjected to the following routine test.
(i)Power frequency voltage dry test
(ii)Measurement of resistance of the main circuit
(iii)Operating test.

4.5.8.3 The porcelain will have pull out test for embedded component and beam strength of porcelain base.

4.5.9 AUXILIARY SWITCHES

4.5.9.1 All isolators and earth switches shall be provided with 220/110 volts, 6 Ampere auxiliary switches for their remote position indication on the control board and for electrical interlocking with other equipment. In addition to the auxiliary switches required for remote position indications and for their operation. There shall be six pairs of NO and six pairs of NC contacts for each isolating switch and three pairs of NO and three pairs of NC contacts for each earthing switch. All contacts shall be brought out to terminal blocks

4.5.10 CONNECTORS

4.5.10.1 Each isolator shall be provided with appropriate number of bimetallic clamping type connectors as detailed in the schedule of requirement. The maximum length of jumper that may be safely connected or any special instruction considered necessary to avoid under loads on the post isolators should be stated by the bidder.

4.5.11 MOUNTING STRUCTURES

4.5.11.1 All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on structures.

4.5.12 TECHNICAL DATA SHEET FOR ISOLATORS

No.	Technical Particulars	Isolators class
		33 kV
1	Nominal system voltage, kV	33
2	Highest system voltage, kV	36
3	Rated frequency, Hz.	50
4.	Type of Isolator	Double Break, centre pole rotating
5	Rated continuous current, A	1250

6	Rated short time current, kA	25
7	Rated duration of short time current, (second)	1
8	Rated lightning impulse withstand voltage, kV (peak)	
	i) To earth & between poles	170
	ii) Across isolating distance	180
9	Rated 1 minute power frequency withstand voltage, kV (rms)	
	i) To earth & between poles	70
	ii) Across isolating distance	80
10	Minimum Creepage distance of insulators, mm	31mm/kV
11	Temperature rise	As per relevant IS

4.6.0 TECHNICAL SPECIFICATION FOR SURGE ARRESTORS

4.6.1 SCOPE

4.6.1.1 This Section covers the specifications for design, manufacture, shop & factory testing before dispatch of 33 kV 10 kA, Station class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with fittings & accessories.

4.6.2 STANDARDS

4.6.2.1 The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 unless otherwise specifically specified in this Specification

4.6.3 GENERAL REQUIREMENT

4.6.3.1 The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.

4.6.3.2 The surge arrestor shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing/silicon polymeric of specified creepage distance.

4.6.3.3 The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.

4.6.3.4 The surge arrestor shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing/system to the Surge Arrestor.

4.6.3.5 The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.

4.6.3.6 The surge arrestor shall be suitable for circuit breaker performing 0-0.3sec.-CO-3min-CO- duty in the system.

4.6.3.7 Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain/ silicon polymeric housing and providing path for flow of rated fault currents in the event of arrestor failure.

4.6.3.8 The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

4.6.3.9 The Surge Arrestor shall be thermally stable and the bidder shall furnish a copy of thermal stability test with the bid.

4.6.3.10 The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

4.6.4 ARRESTOR HOUSING

4.6.4.1 The arrestor housing shall be made up of porcelain/***silicon polymeric*** housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown colour, free from blisters, burrs and other similar defects.

4.6.4.2 Arrestors shall be complete with insulating bases, fasteners for stacking units together, surge counters with leakage current meters and terminal connectors.

4.6.4.3 The **housing shall be so coordinated that external flashover shall not occur due to application of** any impulse or switching surge voltage up to the maximum design value for arrestor. The arrestors shall not fail due to contamination. The arrester housings shall be designed for pressure relief class as given in Technical Parameters of the specification.

4.6.4.4 Sealed housings shall exhibit no measurable leakage.

4.6.5 FITTINGS & ACCESSORIES

4.6.5.1 The surge arrestor shall be complete with insulating bases, fasteners for stacking units together, surge counters with leakage current meters and terminal connectors.

4.6.5.2 The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built-in clamping device which can be adjusted for both horizontal and vertical takeoff.

4.6.5.3 Grading corona control rings if necessary shall be provided on each complete arrestor pole for proper stress distribution.

4.6.6 SURGE MONITOR

4.6.6.1 A self-contained discharge counter suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit. Leakage current meter with suitable scale range to measure leakage current of surge arrestor shall also be supplied within the same enclosure. The number of operations performed by the arrestor shall be recorded by a suitable cyclometric counter and surge monitor shall be provided with an inspection window. There shall be a provision for putting ammeter to record the current/alarm contacts in the control room if the leakage current exceeds the permitted value. Similar provision shall be considered for surge counter also.

4.6.6.2 Surge monitor shall be mounted on the support structure at a suitable height so that the reading can be taken from ground level through the inspection window and length of connecting leads up to grounding point and bends are minimum.

4.6.7 TESTS

4.6.7.1 **Test on Surge Arrestors**

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 3070 (Part-3). In addition, the suitability of the Surge Arrestors shall also be established for the following:

Residual voltage test
Reference voltage test
Leakage current at M.C.O.V
P.D. test
Sealing test
Thermal stability test
Aging and Energy capability test
Watt loss test
Each metal oxide block shall be tested for guaranteed specific energy capability in addition to routine/acceptance test as per IEC/IS.

4.6.7.2 The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 2071.

4.6.7.3 **Galvanization Test**

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS: 2633 & IS 6745.

4.6.8 NAME PLATE

4.6.8.1 The name plate attached to the arrestor shall carry the following information:

Rated Voltage

Continuous Operation Voltage

Normal discharge current

Pressure relief rated current

Manufacturers Trade Mark

Name of Sub-station

Year of Manufacturer

Name of the manufacture

Purchase Order Number along with date

4.6.9 TECHNICAL DATA SHEET FOR SURGE ARRESTOR

	Particulars	**Voltage class**
		33 kV
1	Rated voltage of arrester, kV	30
2	Rated frequency, Hz	50 Hz
3	Nominal discharge current of arrester, kA	10
4	Maximum residual voltage at nominal discharge current, kV (peak)	108
5	Maximum steep current impulse residual voltage at kV (kVP)	120
6	One minute power frequency withstand voltage of arrester insulation, kV (rms)	70
7	1.2 / 50 □ second impulse withstand voltage of arrester insulation, kV (peak)	170
9	Line discharge class	2
10	**Insulator Housing**	
	Power frequency withstand test voltage(wet) (kV rms)	70
	Lightning impulse withstand tests voltage (KVp)	170
	Pressure Relief Class	40
	Creepage distance not less than (mm)	31mm/kV

4.7.0 TECHNICAL SPECIFICATION FOR CONTROL AND RELAY PANELS (WITH AUTOMATION)

SCOPE

This Section is intended to cover the design, manufacture, assembly, testing at manufacturer's works of Indoor Relay and Control Panels.

The Control and Relay Panels required are for control and protection of the Power Transformers, Feeders and for others according to requirements. The supply shall include all accessories, special tools, relevant software, supporting steels, spare parts, drawings, instruction manuals etc. The panels shall be supplied complete with all accessories as specified and completely assembled and all internal wiring completed.

The sub-stations will have automation as per guidelines of IEC 61850. The contractor has to supply the C&R panels to match the requirement of Sub-station Automation System (SAS) as specified in the subsequent chapter.

STANDARDS

All equipment and all component parts supplied under this specification shall conform in all respects to the latest issue of relevant Indian Standard Specifications except where specified otherwise in this specification. Equipment meeting any other authoritative standards which ensure an equal or better quality may also be acceptable.

TYPE OF PANEL

All panels shall be simplex type. One simplex panel shall be used for each feeder and bus coupler / by pass breaker. For transformer bays two simplex panels (one each for HV and LV sides) may be used if required.

Simplex Control and Relay Panels shall consist of vertical swing front panels with equipment mounted thereon and having front glass door. Each cubicle assembly shall be provided with doors on the rear having handles with built in locking facility. It shall have double leaf doors with lift off hinges at the back for panels of width more than 800 mm.

These panels shall be of the following approximate dimensions: Height: 2250mm + 15mm anti-vibration pad + 50 mm (base) Depth: 800mm (MAX)

Width: 800 mm to 1000 mm

CONSTRUCTIONAL FEATURES

The panels shall be completely metal enclosed to ensure a dust, moisture and vermin proof atmosphere. The enclosure shall provide a degree of protection not less than IP 31 in accordance with IS-2147

Panels shall be rigid free standing and floor mounting type and comprise of structural frames enclosed completely with specially selected texture finished, cold rolled sheet steel of thickness not less than 3mm for weight bearing members of the panels such as base frame, front sheet and door frames and not less than 2.0 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

All joints shall be made flush and all edges shall be bent at right angles and rounded. All structural members shall be bolted or welded together. Necessary arrangement shall be provided for bolting together the adjacent panels as well as for fastening them to the floor. The opening required for mounting the equipment shall be punched or cut and filed smooth.

All doors, removable covers and panels shall be sealed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming to provision of IS 11149. However, XLPE gaskets can also be used for fixing protective toughened glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

Panels shall have additional rolled channel plinth at the bottom with smooth bearing surface. The panels shall be fixed on the embedded foundation channels with intervening layers of anti-vibration strips made of shock absorbing materials which shall be supplied by the contractor.

MOUNTING OF EQUIPMENTS

All equipment on and in the panels shall be mounted and completely wired to the terminal blocks ready for external connection. All equipment on the front panels shall be mounted flush. Terminal markings shall be clearly visible.

INTERNAL WIRING

Panels shall be supplied completely with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and wiring shall be carried out internally. These adjacent inter panel wiring shall be clearly indicated in the drawing furnished by the CONTRACTOR.

Wiring shall be carried out with 1100-Volt grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of stranded copper conductor used for internal wiring shall be as follows:

(a) All circuits except instrument transformers circuits:

(b) Instrument transformers circuit:

1.5 sq. mm. per lead.

2.5 sq. mm. per lead.

Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panel running throughout the entire length of the panels.

Wire terminals shall be made with solder less clamping type of tinned copper lugs, which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from blocks.

Interconnections to adjacent panels shall be brought out to a separate set of terminals blocks located near the slots or holes meant for taking the interconnecting wires. Arrangement shall permit easy inter connection to adjacent panels at site and wires for this purpose shall be provided by the CONTRACTOR looped and bunched properly inside the panel.

A laminated copy of total schematics is to be fixed on the inside of door.

TERMINAL BLOCKS

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be of 650 volts grade and have 10 amps continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal

block designs include a white fibre-marking strip with clear plastic/silicon chip on terminal covers. Marking on the terminal strips shall correspond to block and terminal number on the wiring diagram.

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

At least 20% spare terminals shall be provided on each panel and these terminals shall be uniformly distributed on all terminal blocks.

There shall be a minimum clearance of 250 mm between first row of terminal blocks and associated cable gland plates. Also, the clearance between two rows of terminal blocks shall be a minimum of 150mm. A steel strip shall be connected between adjacent terminal block rows at 450-mm intervals for support of incoming cables.

PAINTING

All Sheet steelwork shall be phosphated in accordance with IS 6005.

Oil grease, dirt and warp 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.

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 2(two) coats of ready mixed, stoving type zinc chromate primer. The first coat may be 'flash dried' while the second shall be stoved.

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 completion of tests. Exterior Paint shall be texture finishing with RAL 7032 paint shade.

Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

The inside of the panels shall be glossy white.

A small quantity of finishing shall be supplied minor touching up required at site after installation.

NAME PLATES AND MARKINGS

All equipment mounted on front and rear side as well as equipment mounted inside the panel shall be provided with individual nameplates with equipment designation engraved. Also, on the top of the each panel on front as well as rear side large and bold name plates shall be provided for circuit /feeder designation.

All front mounted equipment shall be also provided at the rear with individual name plates engraved with Tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring. The nameplates shall be mounted directly by the side of the respective equipment and shall not be hidden by the equipment wiring.

Nameplates shall be made of non-rusting metal or 3 ply lamicord. Nameplates shall be black with white engraved lettering.

MISCELLANEOUS ACCESSORIES

A 240 Volts, single-phase plug points shall be provided in the interior of each cubicle with ON-OFF switch for connection of headlamp.

Each panel shall be provided with a LED lighting fixtures for the interior illumination of the panel complete with all fittings, i.e. lamp, switch (controlled by panel door)

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of D.C. and A.C. supplies of various control, AC-DC super vision, signaling, lighting and space heater circuits. MCBs of requisite capacity with fail indicators shall be used, HRC fuse is not acceptable. The main input A.C. and D.C. circuits will be protected with miniature circuit breakers.

EARTHING

All panels shall be equipped with an earth bus securely fixed along with inside base of the panels. The materials and the sizes of the bus bar shall be at least 25X4 mm copper. When several panels are mounted joining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provisions shall be made for extending the earth bus bar to future adjoining panels on either side.

All metallic cases of equipment shall be connected to the earth bus by independent copper wires of size not less than 2.5 sq. mm. Earthing wire shall be connected on terminals with suitable clamp connectors and soldering shall not be permitted.

PT and CT secondary neutrals or common lead shall be earthed at one place only at the terminal blocks, where they enter the panels.

4.8.0 TECHNICAL SPECIFICATION FOR SAMAST COMPLIANT INTERFACE ENERGY METER (IEM)

1. Interface Energy Meters Technical Specification

The specification covers the design, engineering, manufacturing, assembly and testing of static/electronic Interface Energy Meters) compliant Tri-vector type, Four Quadrant, Bi-Directional Energy Meter, suitable for 3-ph 4wire connections solidly earthed system with balanced and un-balanced loads for a power factor range from zero to unity (lagging & leading), with initial and sustained accuracy of class 0.2s. The energy metering system specified herein shall be used for tariff metering for bulk, inter-utility power flows. Projection mounted type, static composite meter shall be installed for EHV/HV circuit, as a self -contained device for measurement of active energy transmittals in each successive 15 minute or 5 minute block etc. meeting the ABT requirements. These meters shall be integrated in SAMAST framework as an when it goes live so the meter shall comply to SAMAST guidelines. The meter shall also be compatible for integration with SAS system. Necessary isolation and /or suppression shall also be built-in for protecting the meter from surges, voltage spikes, fault-current etc. that occurs in VT and CT circuits of extra high voltage switchyards.

2. Basic Features of Interface Energy Meters

a) The energy metering system specified herein shall be used for tariff metering for bulk, inter-utility power flows, in different States of India. Static composite meter shall be installed at interface points as a self-contained device for measurement of Voltage (V), Frequency (f), Active (Wh) and Reactive (VArh) energy exchanged in each successive 5 min time block. All meters shall be compliant to IS 15959 and its latest amendments.

b) Each meter shall have a unique identification code, which shall be marked permanently on its front, as well as in its memory. All meters supplied to as per this specification shall have their identification code starting with "IEM", which shall not be used for any other supplies. "IEM" shall be an eight-digit running serial number, further followed by "A" and "B" for the use with CT secondary of 1A and 5A respectively. This shall be mutually agreed between the buyer and the vendor.

c) The meters shall be suitable for communication with external device like modem, DCU, etc. which shall be able to communicate with CDCS for local/remote data transfer. The meter shall compulsorily have at least 1 optical port for taking reading through Hand Held Unit (HHU).

d) Auxiliary Supply to IEM- The meters shall normally operate with the power drawn from DC auxiliary power supply (Range110V to 220V DC) to reduce the Voltage Transformer (VT) burden. In addition, there shall be provision to operate the meter from the Voltage Transformer (VT) secondary circuit having a rated secondary line-to-line voltage of 110V, and current transformers (CTs) having a rated secondary current of 1 A or 5A. Any further transformers/ transactions/ transducers required for their functioning shall be in-built in the meters. Necessary isolation and/or suppression shall also be built-in, for protecting the meters from surges and voltage spikes that occur in the VT and CT circuits of extra high voltage switchyards. The reference frequency shall be 50Hz. Also, the meter shall have suitable tolerance (up to 15% either side) for DC supply.

e) The meters shall safely withstand the usual fluctuations arising during faults etc. In particular, VT secondary voltages 115% of Vref applied continuously and 190% of Vref for 3.0 seconds, and CT secondary current 150% of Iref applied continuously and 30 times of Iref applied for 0.5 seconds shall not cause any damage to or maloperation of the meters.

f) The meters shall continue to function for the remaining healthy phase(s), in case one or two phases of VT supply fails. In case of a complete VT supply failure, the computation of average frequency shall be done only for the period during which the VT supply was available in the 5-minute block. Any time block contraction or elongation for clock correction shall also be duly accounted for.

g) The total burden imposed by a meter for measurement and operation shall be defined as per IS 14697. An automatic backup for continued operation of the meter's calendar-clock, and for retaining all data stored in its memory, shall be provided through a long-life battery, which shall be capable of supplying the required power for at least 2 years. The meters shall be supplied duly fitted with the batteries, which shall not require to be changed for at least 10 years, as long as total VT supply interruption does not exceed two years. The battery mounting shall be designed to facilitate easy battery replacement without affecting PCB of the meter.

h) The meters shall fully comply with all stipulations in IS 14697 except those specifically modified by this specification. The reference ambient temperature shall be 27 ℃.

i) Each meter shall have a test output device (visual), as per clause 6.11 of IS 14697.1999, for checking the accuracy of active energy (Wh) measurement. The preferred pulsing rate is twenty (20) per Wh for CT sec-1A and four (4) per Wh for CT sec –5A. It shall be possible to couple this device to suitable testing equipment also.

j) Exception Management- The three line-to-neutral voltage shall be continuously monitored and in case any of these falls below defined threshold (70% of Vref), meter shall have suitable indication on LED/ LCD. The meter shall also have provision for low voltage event logging in meter memory in case of any phase voltage going below a defined threshold. The time blocks in which such a voltage failure occurs/persists shall also be recorded in the meter's memory with a symbol "*" if 3 Phase RMS voltage applied to the IEM is in between 5% to 70% of Vref and if Voltage is less than 5% of Vref, meter should record Zero voltage symbol "Z".

k) Time Accuracy - Each meter shall have a built-in calendar and clock, having an accuracy of 10 seconds per month or better. The calendar and clock shall be correctly set at the manufacturer's works. The date (year-month-day) and time (hour-min.-sec.) shall be displayed on the meter front on demand. Meter shall have the intelligence to synchronize the time with GPS (Local GPS/CDCS GPS/ NAVIC) signal and from PC using software. Limited time synchronization through meter communication port shall be possible at site. When an advance or retard command is given, twelve subsequent time blocks shall be contracted or elongated by five seconds each. All clock corrections shall be registered in the meter's memory and suitably shown on print out of collected data.

l) A touch key or push button shall be provided on the meter front for switching on the display and for changing from one indication to the next. The display shall switch off automatically about one minute after the last operation of touch key/push button. When the display is switched on, the parameter last displayed shall be displayed again, duly updated.

m) The whole system shall be such as to provide a print out (both from the local PC, and from remote central computer) of the following format:

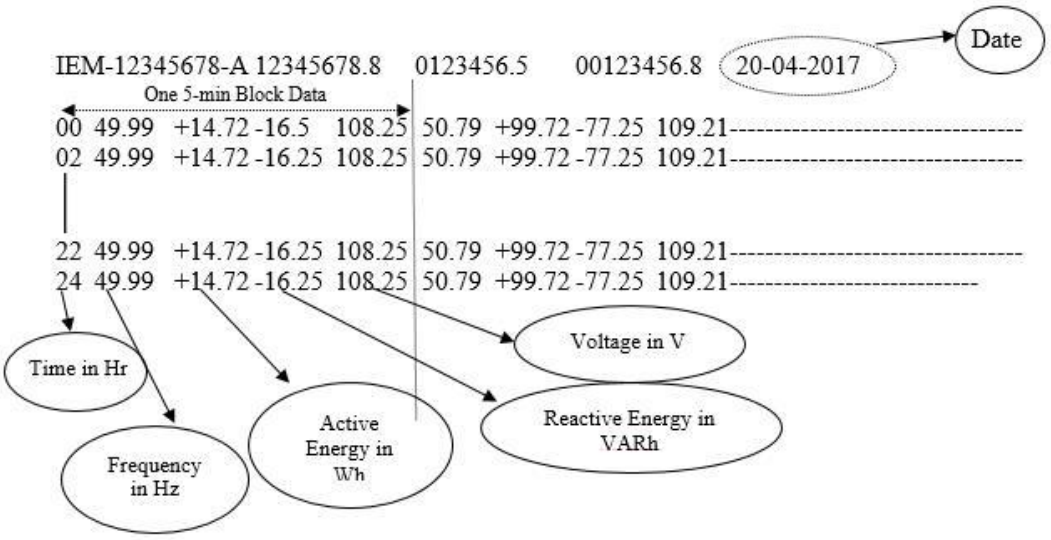

Figure 1: Standard Raw Data Format for IEM

There are 4 values in one 5 min time block. The first row shall contain the meter data for 2 hours, i.e., 24-time blocks, 00 hrs to 02:00 hrs. Similarly, the 2nd row shall contain the data for the next 2 hours and henceforth.

The above data shall be available in text file format (file extension as per IEEE standard/.txt) exportable to Excel. Indication of time retard or advance to be provided without disturbing the proposed format. Each 5-min block data consists of Frequency (in HZ), Active energy (in Wh), Reactive energy (in VARh) and Voltage (in V). All 5-minute Wh and VARh figures in. NPC/output report shall be rounded off upto third decimal.

n) The portable Hand-Held unit (HHU)/ Common meter reading instrument (CMRI)/ Data Collecting Device (DCD) shall be having IS-15959:2011 compatibility for standardized parameters. The optical coupler for tapping data stored in the SEMs memory shall be compatible universally across different make of SEMs.

o) **Constructional Features**

- The meters shall be supplied housed in compact and sturdy, metallic or moulded cases of non-rusting construction and/or finish. The cases shall be designed for simple mounting on a plane,

vertical surface such as a control/relay panel front. All terminals for CT and VT connections shall be arranged in a row along the meter's lower side. Terminals shall have a suitable construction with barriers and cover, to provide a secure and safe connection of CTs and VTs leads through stranded copper conductors of 2.5 sq. mm. size.

- All meters of the same model shall be totally identical in all respects except for their unique identification codes. They shall also be properly sealed and tamper evident, with no possibility of any adjustment at site, except for transactions allowed in IS 15959.

- The meters shall safely withstand, without any damage or mal operation, reasonable mechanical shocks, earthquake forces, ambient temperature variations, relative humidity etc. in accordance with IS-14697. They shall have an IP-51 category dust-tight construction, and shall be capable of satisfactory operation in an indoor, non-air-conditioned installation.

- Either the meters shall have built-in facility (e.g., test links in their terminals) for in-situ testing, or a separate test block shall be provided for each meter.

3. Measurement

a) The active energy (Wh) measurement shall be carried out on 3-phase, 4-wire principle, with an accuracy as per class **0.2S** (IS 14697).

b) The meter shall compute the net active energy (Wh) sent out from the substation bus bars during each successive 5 min block, and store it in its memory up to fourth decimal with plus sign if there is net Wh export and with a minus sign if there is net Wh import. Further Wh data in NPC/output report shall be rounded upto third decimal.

c) The meter shall count the number of cycles in VT output during each successive 5 min block, and divide the same by 300 (60 sec/min x 5min) to arrive at the average frequency. The frequency data shall be stored in the meter's memory in Hertz up to third decimal. Further Frequency data in NPC/output report shall be rounded off upto second decimal.

d) The meter shall continuously compute the average of the RMS values of the three line-to-neutral VT secondary voltages as a percentage of 63.51 V, and display the same on demand. The accuracy of the voltage measurement/computation shall be at least 0.5%, a better accuracy such as 0.2% in the 95-105% range being desirable. The voltage data shall be stored in the meter's memory in volts up to third decimal. Further voltage data in NPC/output report shall be rounded off upto second decimal.

e) The Reactive energy (VARh) measurement shall be carried out on 3-phase, 4-wire principle, with an accuracy of 0.5S as specified in IS 14697. The meter shall compute the net Reactive energy (VARh) sent out from the substation bus bars during each successive 5 min block, and store it in its memory up to fourth decimal with plus sign if there is net VARh export and with a minus sign if there is net VARh import. It shall also display on demand the net VARh sent out during the previous 5 min block. Further VARh data in NPC/output report shall be rounded off upto third decimal.

f) The meter shall also integrate the reactive energy (VARh) algebraically into two separate registers, one for the period for which the average RMS voltage is above 103.0%, and the other for the period for which the average RMS voltage is below 97.0 %. The current reactive power (VAR), with a minus sign if negative, and cumulative reactive energy (VARh) readings of the two registers (>103% and <97%) shall be displayed on demand. The readings of the two registers at each midnight shall also be stored in the meter's memory. When reactive power is being sent out from substation bus bars, VAR display shall have a plus sign or no sign and VARh registers shall move forward. When reactive power flow is in the reverse direction, VAR display shall

have negative sign and VARh registers shall move backwards. Generally, the standard PT ratios are 220 kV /110 V, 400 kV /110 V and 765 kV / 110 V. However, at the time of commissioning the vendor may confirm the same from site and configure the meter accordingly to ensure correct recording of reactive energy.

g) For CT secondary rating of 5A, all computations, displays and memory storage shall be similar except that all figures shall be one fifth of the actual, worked out from CT and VT secondary quantities.

h) Further, the meter shall continuously integrate and display on demand the net cumulative active energy sent out from the substation bus bars up to that time. The cumulative Wh reading at each midnight shall be stored in the meter's memory. The register shall move backwards when active power flows back to substation bus bars.

i) Errors for different power factors shall be as defined in IS14697.

j) For reactive power (VAR) and reactive energy (VARh) measurements, IS14697 shall be complied with. The accuracy of measurement of reactive energy shall be as per class 0.5S.

k) The harmonics shall be filtered out while measuring Wh, V and VARh, and only fundamental frequency quantities shall be measured/computed.

l) Data security shall be ensured as per IS 15959 (three layers of security).

4. Memory/ Storage

Each meter shall have a non-volatile memory in which the following shall be automatically stored:

i. Average frequency for each successive 5 min block, in Hertz up to third decimals.

ii. Net Wh transmittal during each successive 5 min block, up to fourth decimal, with plus sign if there is net Wh export and with a minus sign if there is net Wh import.

iii. Net VARh transmittal during each successive 5 min block, up to fourth decimal, with plus sign if there is net VARh export and with a minus sign if there is net MVARh import.

iv. Cumulative Wh transmittal at each midnight, in eight digits including one decimal.

v. Cumulative VARh transmittal for voltage high condition, at each midnight in eight digits including one decimal.

vi. Cumulative VARh transmittal for voltage low condition, at each midnight, in eight digits including one decimal.

vii. Average RMS voltage for each successive 5min block.

viii. Date and time blocks of failure of VT supply on any phase, as a star (*)/ (Z) mark.

ix. The meters shall store all the above listed data in their memories for a period of fifteen (15) days. The data older than fifteen (15) days shall be erased automatically

x. The software provided at CDCS, i.e., SLDC, will manage all functionalities of collection of data through DCUs, validate the data, store the data in a database, and manage the complete system. Software will also have a scheduler for scheduling the task of collection of data periodically. The periodicity of data collection shall be user defined.

5. Display

Each meter shall have digital display for indication of the following (one at a time), on demand:

i. Meter serial no. and model: IEM12345678A or IEM12345678B

ii. Date (year month day /yyyy mm dd): 20160311 d

iii. Time (hour min sec /hh mm ss): 195527 t

iv. Cumulative Wh reading: 1234567.8 C

v. Average frequency of the previous block: 49.89 F

vi. Net Wh transmittal during the previous block: - 28.75 E

vii. Net VARh transmittal during the previous block: - 18.75 R

viii. Average % Voltage: 99.2 U

ix. Reactive power (VAR): 106.5 r

x. Voltage - high VARh register reading: 1234567.5 H

xi. Voltage - low VARh register reading: 1234567.4 L

xii. Low battery indication

xiii. The three line-to-neutral voltages shall be continuously monitored and in case any of these falls below 70 %, a preferably flashing three LEDs (one LED/phase) provided on meter's front shall become steady. They shall go off if all three voltages fall below 70 %. The LED shall automatically resume flashing when all VT secondary voltages are healthy again.

xiv. The two VARh registers (xv and xvi) shall remain stay-put while VT supply is unhealthy.

Any other better or more informative mechanism to display the above shall be preferred. The above shall be mutually agreed between the meter buyer and vendor.

Navigation keys to be provided at the meter front plate to navigate the display menu.

6. Communication

a) Each meter must have an optical port on its front for tapping all data stored in its memory through HHU. In addition to the above each meter shall also be provided with a RS-485, Ethernet and USB port on one of its sides, from where all the data stored in the meter's memory can also be transferred to CDCS (through DCU), local computer and external storage. The overall intention is to tap the data stored in the meter's memories at a scheduled time from any of the above-mentioned ports or any other means and transmit the same to a remote central computer using suitable means of communication. It shall be possible to securely download the IEM data through an USB port via external storage thereby removing the requirement of an MRI (Meter Reading Instrument). It shall be ensured that data transfer through USB

shall be unidirectional only i.e., from Meter to external storage device in an authentication process. Meter data shall be tamper-proof.

b) All meters shall be compatible with Optical port, RS-485 port, Ethernet port and USB / RS-232 port all together at a time and communicate independently. It shall also be possible to obtain a print out (hard copy) of all data collected from the meters, using the local PC. Data collection from any local laptop/PC shall be possible by installing data collection software. Entire project has to be based on Optic Fibre/GSM/4G/3G. Bidder should quote considering availability of Optic Fibre at 80% of locations and availability of PLCC/4G at 20 % of locations. This is for bringing all the bids on common platform. However, the selected agency will have to conduct detailed survey regarding availability of the particular service for all locations. The bidder may conduct Field Survey before submission of bid.

c) The bidder shall adhere to the appropriate security algorithm for encryption and decryption

Entire project has to be based on Optic Fibre/GSM/4G/3G. Bidder should quote considering availability of Optic Fibre/PLCC/4G/3G/2G for all the locations. However, the selected agency will have to conduct detailed survey regarding availability of the particular service for all locations. Bidders may do Site Survey for availability of communication media prior to submission of bids.

The bidder may design appropriate architecture for providing end to end metering solution. He is free to decide upon the best solution out of all the available options to ensure that data from all IEMs in ASSAM are available at State Load Despatch Centre by the scheduled time. However, the entire responsibility of fully functional end to end metering system shall rest with the bidder in order to meet the performance levels as given in this document. The communication provider may adopt Optical Fibre/GSM/3G/4G communication technology or a combination of these technologies as per the site requirement adopting best available technology in the proposed area of implementation. The successful bidder shall be responsible for proper data exchange among IEM, DCU, CDCS, MDP and other operational/requisite software as part of fully functional metering system.

The bidder shall design a reliable, interference free & robust communication network keeping in view the site conditions. It shall be flexible in terms of providing communication in variable terrain & urban density. The bidder shall design the network architecture keeping in view the existing and planned infrastructure of the utility. During designing, suitable consideration shall be kept for future expansion as per requirement of Utility. Before designing the communication network, the bidder shall do the site survey and would provide the most efficient communication infrastructure. The entire infrastructure & associated civil works required for installation & commissioning of equipment/devices like DCUs, repeaters, routers & access points etc. shall be in the scope of bidder. The operational testing of all the network elements has to be demonstrated by the bidder to the satisfaction of the utility.

d) The Bidder shall provide the necessary software which would enable a local PC/ CDCS to:

   i. Accept the data from the Optical/Ethernet/WAN and store it in its memory in user defined formats (text, csv, xls, etc.) in a user-defined file name (file name format must be ddmmyy substation name-utility name).

   ii. Polling feature along with a task scheduler to run the data downloading software at a pre-designated date and time repeatedly or by manually selecting a meter. File naming for such downloaded data should also be in user-defined format. A detailed activity log shall also be available for each downloading operation.

   iii. Upload/Import meter data (binary files) in the software for further processing. While uploading, there shall be provision to upload all selected files with single key-stroke.

iv. Convert the binary file(s) to text file(s). There should be provision to select multiple files based on filename, convert all selected files with single key-stroke and store the text files in the same location where binary files are stored.

v. Display the collected data on PC's screen in text format, with forward/backward rolling

vi. Print out in text format the data collected from one or more meters, starting from a certain date and time, as per operator's instructions

vii. Transmit the collected data, in binary format, through an appropriate communication link to the central computer, starting from a certain date and time, as per operator's instructions.

viii. Store the collected data in binary format, on a CD/Pen Drive. In addition to above, in general the software shall be able to convert IEMs data to existing format as well as in tabular (.csv) format as applicable.

e) The above software shall further ensure that absolutely no tampering (except erasing of complete data with password protection) of the collected metering data is possible during its handling by the PC. The software shall be suitable for the commonly available PCs, (Windows) and shall be supplied to Owner in a compatible form to enable its easy loading into the PCs available (or to be installed by the Owner/others) at the various substations.

f) The bidder shall ensure data integrity checks on all metered data received from data collection systems.

g) The quality of installation of the various equipment & power supply wiring to all field equipment shall be as per standards/ regulations/prevailing practices of the utility. The supply of electricity needed for operation and maintenance of entire Metering system shall be provided free of cost by the respective owners of the premises.

7. Quality Assurance

The quality control procedure to be adopted during manufacturing of the specified equipment shall be mutually discussed and finalized in due course, generally based on the established and proven practices of the manufacturer. The software shall be user friendly which can be easily installed in any PC/Laptop irrespective of operating system of the PC/Laptop, and shall be certified for ensuring data handling capabilities. The same shall be demonstrated by the party during technical evaluation. During demonstration party shall bring standard meter. Thereafter software shall be offered for technical compatibility before taking up further necessary action in the procurement process

8. Testing

a) All equipment, after final assembly and before dispatch from manufacturer's works, shall be duly tested to verify that is suitable for supply to the Owner. Routine and acceptance tests shall be carried out on the meters in line with IS 14697.

b) Any meter which fails to fully comply with the specification requirements shall be liable to be rejected by the Owner. However, the Owner may purchase such meters at a reduced price in case of marginal non-compliance, at his sole discretion.

c) Acceptance Tests for PC Software and data down loading using meter communication ports- All IEMs after final assembly and before dspatch from Bidder's/Manufacturer's works shall be duly tested to verify that they are suitable for downloading data using meter communication ports shall be subjected to the following acceptance test.

i. Downloading Meter Data from the Meter(s) to PC via optical port.

ii. Downloading meter data through USB port and RS 232.

iii. Downloading meter data to DCU/CDCS through Ethernet as well as RS 485 port.

iv. Compatibility with PC Software.

v. Functioning of Time synchronization, advance and retard time commands.

vi. Per meter downloading time verification.

d) Copy of Certificate shall be submitted to SLDC

Type Tests

a) One (1) meter in a batch shall be subjected to the complete range of type tests as per IS14697 and IS15959, after final assembly. In case of any failure to pass all specified tests, the bidder shall arrange to carry out the requisite modifications/replacements in the entire lot of meters at his own cost. After any such modifications and final assembly, two (2) meters selected out of the lot by the Owner's representative shall be subjected to the full range of type tests. The lot shall be accepted by the Owner only after successful type testing.

b) The meters used for type testing shall be separately identified, duly marked, and supplied to the Owner in case they are fully functional and as good as other (new) meters, after necessary touching up/refurbishing. In case this is not possible, the bidder shall provide their replacements at no extra cost to Owner.

c) The Bidder shall arrange all type testing specified above, and bear all expenses for the same.

d) Copy of Test certificate shall be submitted to SLDC.

e) Type test certificates completed in all respect from NABL approved test house shall be submitted along with the offer

9. ANOMALY DETECTION FEATURES

The meter shall have features to detect and log the occurrence and restoration of following anomalies, along with date and time of event: 6.1.1. Phase wise Missing Potential – The meter shall detect missing potential (1 or 2 phases) provided the line current is above a specified threshold. The voltage at that stage would be below a specified threshold.

- Phase wise Current Circuit Reversal – The meter shall detect reversal of polarity provided the current terminals are reversed. This shall be recorded for 1 or 2 phase CT reversal.

- Voltage Unbalance – The meter shall detect voltage unbalance if there is unbalance in voltages.

- Current Unbalance – The meter shall detect current unbalance if there is unbalance in load conditions. Meter should ensure true system conditions before going for current unbalance checks.

- CT Miss – The meter shall detect current miss if the current is below a defined threshold, provided the phase voltage is above a specified threshold. Snapshots of phase wise voltage, phase wise active current and phase wise power factor shall be provided with above specified anomaly events. Further, each meter module shall record the following events along with total duration:

- Power On/Off – The meter shall detect power off if both the auxiliary supplies fail. The event shall be recorded on the next power up. At the same time power on event shall be recorded. No snapshot shall be logged with this event.
- Feeder Supply Fail -This event shall be logged when feeder supply, i.e., all the voltages go below certain threshold. No snapshot shall be logged with this event.

- Last three hundred & fifty (350) events (occurrence + restoration), in total, shall be stored in the meter memory on first in first out basis.
- There shall be five separate compartments for logging of different type of anomalies:

Compartment No. 1	100 events of missing potential
Compartment No. 2	100 events of CT reversal
Compartment No. 3	100 events of power failure/ Power on-off
Compartment No. 4	50 events of transaction related changes as per ICS Category B

Once one or more compartments have become full, the last anomaly event pertaining to the same compartment shall be entered and the earliest (first one) anomaly event should disappear. Thus, in this manner each succeeding anomaly event shall replace the earliest recorded event, compartment wise. Events of one compartment/ category should overwrite the events of their own compartment/ category only. In general persistence time of 5 min. for occurrence and restoration respectively need to be supported in meter.

Anomaly count should increase as per occurrence (not restoration) of anomaly events. Total no. of counts shall be provided on BCS.

4.9.0 TECHNICAL SPECIFICATIONS FOR XLPE INSULATED COPPER CONTROL AND POWER CABLE

This technical specification intends to cover the following:

1. Technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), various sizes of copper conductor, XLPE insulated, voltage upto and including 1100 Volts, extruded PVC inner sheathed, extruded FRLS PVC outer sheathed, GI round wire armoured cables, suitable for solidly grounded system. The cables shall confirm to IS 7098-Part 1 with latest amendments. For cable list refer Table-1 (Sl. no. 1.1 to 1.19).

Note:

1. Tenders will only be considered from the cable manufacturers and any one supplier to whom manufacturer can authorize. The bidder shall have adequate experience of at least 5 years in manufacturing of LT/MV & HT cables and field proven experience of min 5 years.

2. Copper samples from the finished cable drums shall be tested at any 3rd party NABL accredited lab to ensure its purity.

3. The following document shall be attached with technical part of the bid:

i. Duly filled & Signed copy of Annexure-I, II, III & IV

ii. Deviation sheet, if any

Table 1

Sl. no	Power Cable
1	3C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
2	4C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
3	3C X 4 Sq.mm, Copper Power Cable Type: 2XWY
4	4C X 4 Sq.mm, Copper Power Cable Type: 2XWY
5	3C X 6 Sq.mm, Copper Power Cable Type: 2XWY
6	4C X 16 Sq.mm, Copper Power Cable Type: 2XWY
7	3C X 10 Sq.mm, Copper Power Cable Type: 2XWY
8	4C X 10 Sq.mm, Copper Power Cable Type: 2XWY
9	3C X 16 Sq.mm, Copper Power Cable Type: 2XWY
10	2C X 16 sqmm

Sl. no	Power Cable
11	2CX50 sqmm
12	3.5 C X 35 sqmm
13	3.5 CX70 sqmm
14	3.5 C X 95 sqmm
15	3.5 C X 150 sqmm
16	3.5 C X 300 sqmm
17	1 C X 1000 sqmm
18	2C X 6 sqmm
Control Cable (Copper)	
1	2 C, 1.5mmsq
2	4C, 2.5 sq mm
3	5C, 2.5 sq mm
4	7C, 1.5 sq mm
5	7C, 2.5 sq mm
6	10 C, 2.5 sq mm
7	12 C, 2.5 sq mm
8	12 C,1.5 sq mm
9	14 C, 2.5 sqmm
10	17 C,1.5 sqmm
11	19 C,1.5 sqmm
12	19C,2.5 sqmm

4.9.1 Technical Specifications for 1.1 kV grade, Copper conductor, Power and Control cables

This section covers the technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), 1.1KV grade, Multi-stranded Copper conductor, XLPE insulated, extruded PVC inner sheathed, GI round-wire armoured, extruded FRLS PVC ST2 outer sheathed. Power Cables and Control Cables for effectively grounded system, conforming to the latest revisions of IS: 7098 (Part –I), 1988 & as per the technical specifications attached herewith.

1. STANDARDS

The design, manufacture and testing of the cable shall comply with the latest editions/amendments of the following Indian Standards, unless otherwise specified. Equipments complying with equivalent standards shall also be acceptable.

a. IS-7098, 1998 (Part-I) : Cross linked polyethylene insulated PVC sheathed cables for working voltages upto 1100V.
b. IS-3961 : Recommended current ratings for Cables
c. IS 8130-1984 : Specification for conductors for insulated electric cables and flexible cords.
d. IS-3975, 1999 : Low Carbon galvanized steel wires,

		formed wires & tapes for armouring of cables
e. IS-4759	:	Specifications for Hot dipped galvanized coating on round steel Wires
f. IS-5831	:	PVC insulation and sheath of electric cables.
g. IS-10418	:	Drums for electric cables.
h. IS-10810	:	Method of test for cables.

2. SERVICE CONDITION

Service Condition shall be as per General Technical Requirements (GTR).

3. DESIGN AND CONSTRUCTION PERTICULARS

3.1. General

The cables supplied under this specification shall be adequate insulated to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of the cables. The sheathing material shall be high quality PVC based compound. The construction of cable shall be as per IS: 7098 (Part I) – 1988.

Cable shall be designed and manufactured to prevent damage during transportation, installation & operation under all climatic & operating condition

3.2. Technical parameters	
i. Quantity	Refer Table-1
ii. Packaging	Steel drum packaging, each having single length cable ≥ 500 metres (for size less than 1000sqmm.).
iii. Cable Type	A2XWY/ 2XWY (refer Table-
	1 for details)
iv. No. of Cores	Shall be decided during detailed engineering (Cable sizing calculation)
v. Voltage Level	1.1Kv
vi. System Grounding	Solidly Grounded
vii.	Nominal System voltage: 415V ±10%
viii.	
ix.	Nominal System Frequency: 50 Hz
x.	
xi.	Maximum conductor temperature at rated current : 90 deg C
xii.	Maximum conductor temperature at Short-circuit : 250 deg C
xiii.	Conductor Conductor Material : H4-Grade Aluminium of purity > 99.6% Electrolytic grade Copper, Purity > 99.97%
xiv.	Conductor type : Stranded with number of strands as per IS 8130 (Part-I) 1984
xv.	Insulating material : Cross-Linked-Polyethylene (XLPE) Compound.
xvi.	Core Identification Strips : Red, Yellow, Blue & Black (for neutral)

xvii.	Material of Inner Sheath : FRLS, PVC ST-2 Compound

3.3. Conductor

COPPER

The conductors shall be made from high conductivity copper rods complying with IS: 613. The conductor material used shall be electrolytic grade with high purity. *Two sample conductor randomly selected from finished lot of cables, shall be tested for its purity at any 3rd party NABL accredited lab.*

The conductors shall conform to appropriate dimensions, resistance and number of wire in the conductor (number of strands) as given in IS 8130 (Part I): 1984.

3.4. Insulation

The insulating material for power and control cables shall be extruded cross linked polyethylene (XLPE) compound as per IS-7098(Part-I)-1988. The minimum thickness of insulation shall not be less than the values specified in Table-2 of IS-7098 (Part-I)-1988. No negative tolerance shall be applicable for the thickness. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions. The cores shall be identified as per the following colour scheme:

3-Core - Red, Yellow & Blue

3 ½ or 4-Core - Red, Yellow, Blue & Black

3.5. Inner Sheath

The inner sheath shall be extruded FRLS PVC, Type ST2, compatible with thermal rating of insulation conforming to IS-6380-1984. The sheath shall have adequate thickness, mechanical strength, and elasticity, as specified in IS 5831. The material shall be soft thermoplastic type, applied by extrusion method. The thickness of the inner sheath shall be as per IS: 7098 (Part I) and the colour of the inner sheath shall be Grey. The inner sheath shall be so formed that it fits closely on the laid-up cores and could be easily removed without damaging insulation. One or more layer of proofed plastic tape shall be provided over the laid-up core before extrusion.

3.6. Armouring

The armouring arranged over the inner sheath shall consist of one layer of galvanized round steel wires for all sizes of cable. The armour round wire used on the cable shall conform to IS: 3975 for all requirements. The direction of lay of armour shall be opposite to that of the cores. The zinc coating on the galvanized steel strip shall comply with relevant standards.

3.7. Outer Sheath

Extruded outer sheath shall be provided over the armouring. The material used for sheathing shall be FRLS PVC sheath, Type ST-2 base compound conforming to IS 1554/ IS 5831 for power and control cable. The outer sheath shall be so formed that it fits closely on the laid-up armour and could be easily removed without damaging the intermediate sheath and insulation. The colour of the outer sheath shall be black. The thickness of outer sheath shall be in accordance with the IS 1554 (Part-I)-1988. Suitable additives shall be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment.

Cables shall have suitable fillers laid up with the conductor to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the temperature of the cable and compatible with the insulating material. The material shall be of the best quality and workmanship. The fillers and sheath material shall be non-hygroscopic. All materials shall be new, unused and of the finest quality.

4. TESTS

All the tests specified below shall be carried out in accordance with the Indian Standards by the manufacturer in the presence of Purchaser's representative. If the cable fails to pass the test specified, the Purchaser shall have the option to reject it. Shipping release shall be obtained from the Purchaser's representative. The Purchaser, however reserves the right to waive off the inspection.

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards, in addition any test called for by the Purchaser or his representative to ensure that the equipment being supplied fulfils the requirement of the specification.

For test not covered by any code or specifically mentioned in this specification, the test procedures are to be agreed with the Purchaser.

Pre-Dispatch Inspection- The manufacturer shall be given at least 15 days advance notice prior to the commencement of testing, so that Purchaser's representative can plan to witness the tests.

All the tests indicated in the test clause of this specification shall be carried out in the presence of Purchaser's representative by the manufacturer and shall provide all the facilities and equipment for testing.

Six copies of the Test Certificate shall be furnished to the Purchaser for approval prior to dispatch of cables from factory.

Visual check to conform the details given in this specification is to be done. In addition to the above, the general workmanship of the cable drums and cables laid in drums shall be checked.

Manufacturer shall have proper test set up for testing all the routine tests & type tests on finished cables as per IEC.

List of type tests mentioned in the tender specifications shall be conducted on four drum irrespective of type test certificates given or not.

4.1. Type Test

Type tests on four randomly selected cable drums will have to be conducted in the presence of the department's representative. The test samples will be taken from finished cables. This test shall be in accordance to IS: 7098, Part-1,1988.

a) Test on Conductor-
   - Annealing test for copper conductors
   - Tensile test for aluminium conductor
   - Wrapping test for aluminium conductor

b) Conductor Resistance Test

c) Test on Insulation
   - Physical dimension measurement
   - Tensile strength and elongation at break
   - Hot set test
   - Shrinkage test
   - Ageing in air oven

- Water absorption test

d) Test on round Armour
- Physical dimension measurement
- Tensile strength
- Elongation at break
- Torsion test for round wires
- Winding test for firmed wire
- Mass of zinc coating.
- Uniformity of zinc coating
- Resistivity measurement, Resistance test for armour

e) Test on Sheath
- Physical dimension measurement
- Tensile strength & Elongation at break test
- Ageing in air oven
- Loss of mass in air oven
- Shrinkage test
- Hot deformation test
- Heat shock test
- Thermal stability test

f) Insulation Resistance Test

g) High Voltage Test at room temperature

h) Volume resistivity at room temperature & at 90^{o} C. (IS-10810-Part 43)

i) Flammability test

j) *Test requirement of FRLS inner and outer sheath*

The inner and outer sheath of cables shall meet the following test requirements related to flame retardant, low smoke emission, low acid and toxic gas emission. The BIDDERs shall have proper test apparatus to conduct all the relevant tests as per the applicable standards:

k) Flame retardant test on single cable.

l) Oxygen Index Test

The critical oxygen index value shall be minimum 29 when tested at 27+2ºC as per ASTMD-2863

m) Temperature index test

Temperature index value shall be minimum 250ºC at oxygen index of 21 when tested as per NES 715.

n) Flammability test

o) Smoke Density Test

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

p) Acid Gas Generation test (halogen acid gas evolution)

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.

q) Test for specific optical density of smoke

r) Anti termite and rodent property test

The sequence of electric tests shall be as per the relevant Indian/International standards. The Bidder shall submit the sequence of tests for the approval of the purchaser before conducting the tests. A copy of the adopted standard shall also be supplied.

4.2. **Routine Test (On each drum)**

The following routine tests shall be carried out by the Manufacturer on each and every length of the cable in the presence of Purchaser's representative at manufacturer's works.

a. Resistance test for conductors

b. Insulation resistance test

c. High voltage test

4.3. Conductor purity test

Two samples of aluminium and copper shall be taken from any of the finished set of cables at random and the sample shall be tested for its purity at a NABL accredited lab.

Qualifying Criteria:

The test results should be within limits as per IS 7098. All the routine tests as per IS 7098 / IEC shall be conducted and passed as per the limits given in the standards. All the bought-out certificates will be verified and the test results shall be as per respective standards.

5. IDENTIFICATION

The following details shall be marked sequentially for each meter run length of the cable by non-erasable embossing on the outer sheath:

a. Reference to Indian Standard
b. Name of the manufacturer/ Trade Name
c. Name of the project:
d. Configuration of the cable: viz. Voltage grade, no. of Core, Sq. mm, A2XWY/2XWY/YWY / YY as applicable
e. Year of manufacturing
f. Sequential marking of running meter length

The running length of the cable shall be identified at regular intervals of one meter (Increasing order from inner end to outer end of the cable)

6. PACKAGING

· Each drum shall consist of single length cable ≥ 500 metres (for sizes less than 1000sqmm.).

· The cable shall be wound on *non-returnable steel drums* of suitable size, packed and marked.

· Packing shall be sturdy to protect the cable from any injury during transportation, handling and storage. The cut ends of the cable shall be sealed by means of non-hygroscopic sealing material preferably Heat shrinkable end caps.

· One end of the cable shall be brought out of the drum and suitably clamped to the drum flange with proper mechanical protection. Location of the other end may be marked on the drum.

· The cable shall be placed on drums in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. No undue stress shall appear on cables when laid on drums.

· The cable drum shall carry the following information stencilled on a metallic label, securely attached to each end of the drum:

i. Reference to the Indian standard

ii. Manufacturer's name, brand or trade mark

iii. Type of cable and voltage grade

iv. No. of cores

v. Nominal cross-sectional area of conductor

vi. Cable code

vii. Length of cable on drum

viii. No. of lengths on reel, drum or coil (if more than one)

ix. Gross weight

x. Country of manufacture

xi. Year of manufacture

xii. Direction of rotation of drum (an arrow)

xiii. ISI certification mark

7. **PREFERRED MAKE**

POLYCAB/KEI/KEC or reputed brand possessing system certification of ISO 9001:2008, ISO14001:2004, OHSAS18001:2007 & EN 16001-2009 and product certifications IS: 7098 (Part-I), CE, UL etc. Quotations without these certification details will not be considered for technical evaluation.

Preferred make of bought out material:

a.	Aluminium for Conductor	:	Hindalco/Balco/Nalco
b.	Copper for Conductor	:	Hindustan Copper/Hindalco
c.	XLPE compound of Insulator	:	Dow/Borealis

8. GUARANTEE

All the cables shall be guaranteed against faulty material, defective design & poor workmanship for a period of 18 months from the date of commissioning. The materials becoming defective during the guarantee period shall be replaced free of cost and the defects arising out of the works shall be rectified free of charge without delay.

ANNEXURE-I

Technical Data Format for 1.1KV, XLPE Insulated, Copper Cable

The tenderer shall furnish all technical details as called for in the following format for all sizes of cables failing which the tender shall be considered as incomplete. *The details shall be furnished separately for all the cables.*

Sl. No.	Particulars	Details
A	Cores	
1	No. of cores	
2	Nom Area of conductor in sq mm.	
3	Voltage Grade	
B	Conductor	
1	Standard Applicable	
2	Material Copper Grade	
3	Purity	
4	Nominal Cross Sectional Area	
5	Form of conductor/circular shaped	
6	No. of strands	
7	Nominal dia of each strand	
8	Temperature co-efficient of resistance at 20 degree celsius	
C	Insulation	
1	Standard Applicable	
2	Material (Mention Type)	
3	XLPE is cured by steam process or Gas process?	

Sl. No.	Particulars	Details
4	Minimum Average Thickness	
5	Tolerance on the smallest of the measured values of thickness of Insulation	
6	Minimum volume resistivity at 27 deg cel	
7	Minimum volume resistivity at 70 deg cel	
8	Colour Scheme for identification of cores	
9	Average Dielectric Strength	
D	Inner Sheath	
1	Standard Applicable	
2	Material for inner sheath	
3	Minimum thickness of inner sheath	
4	Whether extruded	
E	Armour	
1	Standard Applicable	
2	Shape	
3	Size	
4	Material for Armour	
F	Outer Sheath/Overall Covering	
1	Standard Applicable	
2	Material (type)	
3	Whether extruded	
4	Minimum average thickness	
5	Whether anti-termite treatment has been given in the outer sheath	
6	Whether flame retardant low smoke compound added in the outer sheath	
G	Electrical Properties	
1	Maximum DC Resistance of conductor at 20 deg Celsius in ohms/km	

Sl. No.	Particulars	Details
2	Maximum DC Resistance of amour at 20 deg Celsius in ohms/km	
3	Maximum Permissible conductor temperature	
	Under continuous full load	
	Under transient conditions	
4	Loss Tangent at normal frequency	
5	Reactance at maximum operating temperature 50 Hz (ohm/km)	
6	Capacitance at maximum operating temperature 50 Hz (ohm/km)	
7	Total Impedance at maximum operating temperature 50 Hz (ohm/km)	
8	Recommended continuous current rating	
	In Ground at 30 deg C Ground Temperature (A)	
	In Trench/Ducts at 40 deg C (A)	
	In Air at 40 deg C ambient Temperature (A)	
9	Short Ckt Current Rating for 1 sec duration (in KA)	
	Conductor	
	Armour	
10	Minimum volume Resistivity of insulation	
	At 27 °C in Ohm cm	
	At Max operating temperature in Ohm-cm	
11	Approximate AC resistance at max. Operating temperature	
	Phase	
	Neutral	
H	Mechanical Data	
1	Overall Dia of the cable	
2	Dia of the cable under the sheath	
3	Diameter under armour	
4	Diameter over the stranded cores	

Sl. No.	Particulars	Details
5	Weight of cable per km.	
6	Drum length	
7	Tolerance on drum length	
8	Total weight of the drum	
9	Dimension of the drum	
10	Recommended minimum installation radius/ bending radius	
11	Maximum safe pulling force	
12	Whether identification as per clause of the specification is being provided	
13	Whether packing has been done as per clause of the specification	

4.10 SPECIFICATION OF 36 KV OUTDOOR TYPE PORCELAIN CLAD VACUUM CIRCUIT BREAKERS (PCVCB)

4.10.1 INTRODUCTION

The circuit breakers should be complete in all respects with insulators, bimetallic connectors, interrupting chamber, operating mechanism control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The scope of supply shall also include necessary special tools and plants required for erection as indicated, if any.

4.10.2 STANDARDS

The circuit breaker shall conform in all respects to the requirements of latest issue of IS/IEC specifications except for modifications specified herein. The equipment manufactured according to any other authoritative standards which ensure an equal or better quality than the provision of IS/IEC specifications shall also be acceptable. The salient point of difference between the proposed standard and provision of these specification shall be clearly brought out in the tender. A copy of English version of such specifications shall be enclosed with the tender.

The list of standards mentioned in this specification and to which the circuit conform is given below:

1.	IEC-62271-100	High Voltage A.C. Circuit Breakers
2.	IEC-60137	Bushing for alternating Voltages above 1000 volts
3.	IEC-60071	Insulation Co-ordination
4.	IEC-60694	Common clauses for high voltages switchgear and control gear standards
5.	IEC-60815	Specification for Creepage distances
6.	IS-13118	Specifications for high voltage alternating current circuit breakers
7.	IS-2099	High voltages porcelain bushings
8.	IS-4379	Identification of the contents of industrial gas cylinders
9.	IS-3072	Installation and maintenance of switchgear
10.	IEC-60267	Guide for testing of circuit breakers with respect to out of phase switching
11.	IS-802	Code of practice for use of structural steel in overhead transmission lines
12.	IEC-17A Study Group Dec.198 1	Sealing of interrupters / breakers
13.	IS-1554	PVC insulated cables upto and including 1000 volts
14.	IS-5	Colors for ready mixed paints and channels
15.	Ref.Standard IES	Internal Electro-Technical Commission Bureau Central Data Commission, Electro Technique International, 1, Ruede Verembe, Geneva, Switzerland
16.	IS	Indian Standard Bureau of India Standard, Manak Bhawan 9, Bahadurshah Zafar Marg, New Delhi – 110 002, India

4.10.3 SERVICE CONDITONS CLIMATIC CONDITONS

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation as per section-I.

AUXILIARY POWER SUPPLY

Auxiliary electrical equipment shall be suitable for operation on the following supply system.

a) Power Devices (like motors)	415 V, 3 phase 4 wire 50 HZ, neutral grounded, AC supply
b) DC Alarm, Control and Protective Devices	220/110 V/30 V DC, ungrounded 2 wire (Substation wise exact details shall be furnished by the successful bidder after survey)
c) Lighting	240 V, single phase 50 Hz AC supply

Bidder's scope includes supply of interconnecting cables, terminal boxes, etc. The above supply voltage may vary as indicated below and all devices shall be suitable for continuous operation over the entire range of voltages

i) AC Supply	Voltage + 10% -15% Frequency ± 5%
ii) DC Supply	-15% to + 10%

4.10.4 GENERAL REQUIREMENT OF 36 KV/OUTDOOR VACUUM CIRCUIT BREAKERS

The vacuum type circuit breaker shall have vacuum interrupters, designed to provide a long contact life at all currents upto rated making and breaking current during switching operation. The vacuum interrupters sealed for life shall be encapsulated by porcelain insulators for out door installation requirement of the circuit breakers. The offered breakers shall be suitable for out door operation under climatic conditions specified without any protection from sun, rain and dust storm.

The vacuum interrupters of each phase shall be housed in a separate porcelain insulator. The three identical poles shall be mounted on a common base frame and the contact system of three poles should be mechanically linked to provide three pole gang opening/closing for all type of faults.

i) The offered equipment shall be practically maintenance free over a long period.

ii) All mechanical parts and linkages shall be robust in construction and maintenance free, over at least 10,000 switching operations, except for lubrication of pins/articulated joints at interval of 5 years or 5000 operations.

iii) Similar parts shall be strictly interchangeable without special adjustment of individual fittings. Parts requiring maintenance shall be easily accessible, without requiring extensive dismantling of adjacent parts.

iv) The operating mechanism will be self-maintained and of proper operation endurance not less than the mechanical life of circuit breaking unit. It shall be spring operated type described hereinafter.

v) The circuit breaker shall be supplied complete with all auxiliary equipment, meant necessary for the safe operation, routine and periodic maintenance. All internal wiring including those of spare auxiliary contacts shall be complete and wired up to terminal blocks.

vi) The breaker shall be totally re-strike free under all duty conditions. The details of any device incorporated to limit or control the rate of rise of re-striking voltage across the circuit breaker contacts shall be stated.

vii) The breaker shall be reasonably quiet in operation and the noise level shall not exceed 140 decibels.

viii) The breaker shall be suitable for three phase re-closing operation.

ix) An operation counter, visible from the ground level even with the mechanism housing closed shall be provided.

4.10.5 FIXED AND MOVING CONTACT

The fixed and moving contacts of the breaker have to ensure permanent full contact during closing. All making and breaking contacts shall be hermetically sealed and free from atmospheric effects.

The main contacts should have low contact resistance.

4.10.6 RECOVERY VOLTAGE AND POWER FACTOR

The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor equal to or exceeding 0.15. In case of multiple break circuit breaker, devices/method adopted for ensuring uniform voltage distribution across all the breaks shall be indicated and actual voltage distribution recorded during interruption tests shall be furnished with the bid.

4.10.7 RESTRIKING RECOVERY

The complete data for the phase factor, amplitude factor, etc., for rate of rise of re-striking voltage shall be furnished in the tender.

4.10.8 LINE CHARGING INTERRUPTING CAPACITY

The circuit breaker shall be designed so as to be capable of interrupting line charging currents without undue rise in the voltage on the supply side without re-strike and without showing sign of undue strains.

The maximum permissible switching over voltage shall not exceed 2.5 p.u. The guaranteed over voltage, which will not be exceeded while interrupting the rated line charging current for which the breaker is designed to interrupt shall also be stated. The results of the tests conducted along with the copies of the oscillographs to prove ability of the breakers to interrupt the rated as well as lower values of the line charging current shall be furnished with the tender.

4.10.9 TRANSFORMER CHARGING CURRENT BREAKING CAPACITY

The breaker shall be capable of interrupting inductive currents, such as those occurring while switching off unloaded transformers, without giving rise to undue over voltage and without re-strikes. The maximum over voltage value, which will not be exceeded under such conditions shall be stated in the tender.

4.10.10 BREAKING CAPACITY FOR SHORTLINE FAULTS

The interrupting capacity of the breaker for short line faults shall be stated in the tender. The details of the test conducted for proving the capability of the breaker under a short line fault occurring from one phase to earth conditions shall also be stated in the tender. The rated characteristics for short line faults shall be in accordance with stipulation contained in clause 4.105 of IEC 62271-100.

4.10.11 AUTOMATIC RAPID RECLOSING

36 kV circuit breaker shall be suitable for 3 pole rapid re-closing.

4.10.12 OUT OF PHASE SWITCHING

The circuit breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronization. The maximum power that the breaker can satisfactorily interrupt under "Phase Opposition" shall be stated in the bid".

4.10.13 TEMPERATURE RISE

The maximum temperature attained by any part of the equipment when in service at side and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperature specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the bid.

4.10.14 INSULATORS SUPPORTS AND HOUSING

The porcelain used shall be homogenous, free from cavities and other flaws. The insulators shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. The puncture strength of bushing shall be greater than the flash over value. The design of bushing shall be such that the complete bushing in a self-contained unit and no audible discharge shall be detected at a voltage upto a working voltage (Phase Voltage) plus 10%. The support insulator shall conform to IEC-60137. Minimum clearance between phases, between live parts and grounded objects shall be as per IS-3072-1975 and should conform to Indian Electricity Rules-1956. The minimum creepage distance for severely polluted atmosphere shall be 25 mm/KV as per IEC-815-1985.

The details for atmospheric pollution of various sub-stations where these breakers are to be installed shall be as per Clause 1.3.1 of this specification. The air clearance of bushing should be such that if the bushings were tested at an altitude of less than 1000 meters, air clearance would withstand the application of higher voltages (IS-2099-1973 para 6.1). In order to avoid breakdown at extremely low pressures the support insulators should not be covered by moisture and conducting dust. Insulators should therefore be extremely clean and should have antitracking properties. Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.3 g in horizontal direction.

4.10.15 OPERATING MECHANISM GENERAL REQUIREMENTS

The operating mechanism shall be stored energy type and capable of giving specified duty of the breaker (sequence of opening and closing) as specified under O-0.3 sec-CO-3 min-CO. The breaker shall also pass the operational test which ascertains the capabilities of operating mechanism. The operating mechanism shall be capable to perform the following functions efficiently.

i) To provide means where the circuit breaker can be closed rapidly, at all currents from zero to rated making current capacity.

ii) To hold the circuit breaker in closed position by toggles or latches till the tripping signal is received.

iii) To allow the circuit breaker to open without delay immediately on receiving tripping signal.

iv) To perform auto re-closure duty cycle.

v) To perform the related functions such as indication, contacts, etc.

Operating mechanism should also be suitable for three phase auto re-close duty. The closing spring shall be automatically charged by motor immediately after closing operation. In case of failure of supply to the spring charging motor, the spring shall be chargeable by hand-crank.

a) TRIPPING/CLOSING COILS

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Whereas second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. Provision shall be given for trip circuit supervision both in pre close and post close condition of the breaker. All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch.

b) TRIP FREE FEATURES

When the breaker has been instructed to close by manual instructions using push button, the operating mechanism will start operating for closing operations. If in the meantime a fault has taken place, the relay provision shall be such that it should close the trip circuit simultaneously interrupting the live circuit of closing coil which has been instructed for close command.

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti-pumping device to prevent the circuit breaker from reclosing after an automatic opening shall be provided to avoid the breaker from pumping i.e., anti-pumping relay should interrupt the closing coil circuit.

c) Controls

The circuit breaker shall be controlled by a control switch located in the control cabinet. The control arrangement shall be such as to disconnect the remote control circuits of the breaker, when it is under test. Local control devices, selector switch and position indicator shall be located in weather and vermin-proof cabinet with degree of protection not less than IP-55. The circuit breaker control scheme shall incorporate trip circuit supervision arrangement. Local/remote selector switch shall be provided for all breakers for selection of “Local” control/remote control.

Provision shall be made for local manual, electrical and spring controls. Necessary equipment’s for local controls shall be housed in the circuit breaker cabinet of weather-proof construction. In addition to this, a hand closing device for facilitating maintenance shall also be provided.

Each circuit breaker shall have a mechanical open/closed and spring charge indicator in addition to facilities for provisions for semaphore indicators for breakers which are required for the mimic diagram in the control room. Lamps for indicating, `close/open’ position of the breaker shall also be provided.

The contact pressure spring and tripping spring shall be chargeable during closing operation to ensure the breaker is ready to open. Mechanically ON/OFF indicator, spring charged indicator and operation counter shall be provided on the front of the control cubicle. For tripping, the spring provided shall ensure the trippings.

Mechanical indicator, to show the ‘open’ and ‘close’ position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.

Closing coil shall operate correctly at all value of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. The variation in A.C. supply voltage shall be –15%to +10% while variation in frequency shall be 3. Working parts of the mechanism shall be non-corrosive material. Bearings which require grease shall be equipped with pressure type fillings.

Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.

4.10.16 SPRING OPERATED MECHANISM

The motor compressed spring mechanism shall consists of a closing spring which is wound or compressed by an electric motor immediately after the breaker closes.

After the breaker has tripped, the tripping spring shall remain in the released position as long as the breaker is open, but the closing spring shall remain wound and ready for closing operation. The operating mechanism shall have all the necessary auxiliaries, apparatus for operation and supervision, like motor starter with thermal overload release, one closing coil, two trip coils, push button for local electrical operation, local/remote control selector switch, push button for direct mechanical tripping, auxiliary switches, anti puming contactors, operation counter, socket for inspection, lamp and heater with switch. Spring charging motor shall be standard single phase universal motor suitable for 220 volts supply.

i) Operating voltages for closing/tripping coils shall be 220/110/48/24 Volts DC **or as per actual DC voltage available at existing substations which is to be verified by supplier after award of contract.**

ii) Operating voltages for heater elements shall be 220V AC 50 HZ. Other features of the spring operated mechanism shall be as follows.

a) The spring operating mechanism shall have adequate energy stored in the operating to close and latch the circuit breaker against the rated making current and also to provide the required energy for tripping mechanism in case the tripping energy is derived from the operating mechanism.

b) The mechanism shall be capable of performing the rated operating duty cycle of O-0.3Sec-CO-3 Min-CO...

c) The spring charging motor shall be AC or DC operated and shall not take more than 30 sec., to fully charge the closing spring made for automatic charging. Charging of spring by the motor should not interfere with the operation of the breakers.

d) The motor shall be adequately rated to carry out a minimum of one duty cycle. Also provision shall be made to protect the motor against overloads.

e) In case of failure of power supply to spring charging motor, the mechanism shall be capable of performing one open-close-open operation.

f) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in closed position. Provision shall be made to prevent a closing operation to be carried out with the spring partially charged.

g) Facility shall be provided for manual charging of closing springs.

4.10.17 CONTROL CABINET

The switchgear operating mechanism, the control equipment such switch for closing and tripping the breakers, various control relays, antipuming device, a set of terminal blocks for wiring connections, MCB's for disconnecting the control auxiliary power supplies including relays, etc., shall be enclosed in a cabinet to be mounted on a suitable structure at a convenient working height at the end of the breaker in the outdoor switchyard. The supporting structure and the enclosure shall be capable of withstanding the typical tropical climatic conditions, change of ambient temperature, severe dust-storms, very high relative humidity those are prevailing at the site of location of switchgear.

i) ENCLOSURE

The enclosure shall be made out of stretched level steel plates not less than 3 mm thick and of light section structural steel. It should be weather proof as well as vermin proof.

The enclosure shall provide protection against dust and foreign objects. Each cabinet section shall have full width and full-length hinged doors mounted on the front that swing fully open. The doors shall be provided with latches to securely hold it with the cabinet. Doors shall be of sturdy construction, with resilient material

covering, fully perimetrically contacting the cabinet frame to provide dust protection and prevent metal to metal contact except at the latch points. Filtered ventilation shall be provided along with the rigid supports for control and other equipment, measuring instruments, mounting cabinet members and equipment shall not restrict easy access to terminal blocks for terminating and testing external connection or to equipment for maintenance.

All screws and bolts used for assembling and mounting wire and cable termination, supports, devices and other equipment shall be provided with lock washers or other locking devices. All metal parts shall be clean and free of weld splatter, rust and mill scale prior to application of double coat of zinc chromate primer which should be followed by an under coat to serve as base and binder for the finishing coat. The shade of exterior and interior shall be as per GTR. The mounting structure shall be galvanized and shall be as per IS- 802-II-1978.

ii) HEATERS

Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by thermostat and shall be provided with ON/OFF switches and fuses. Heaters shall be suitable for 240 V AC supply voltage.

iii) LIGHTING

At least one 13-watt CFL fixture and lamp working on 240 V 50 Hz AC supply shall be provided in each switchgear control cubicle section and shall be located suitably to provide adequate interior lighting of the cubicle. A single-pole 6 Amp. lighting switch shall be provided for each cubicle along with 5/15 amp.

The lighting and convenient outlet circuits shall be completely wired in conduit and terminated on cubicle terminal blocks.

iv) WIRING AND CABLING

a) Unless otherwise specified control wire shall be stranded tinned copper switchboard wire with 1.1 kV PVC insulation conforming to the requirements of IS-1554.

b) All the control circuit and secondary wiring shall be wired completely and brought out to terminal block ready for external connections in the control cabinet. The cross-section of control wire shall not be less than 2.5 mm2 copper (14 SWG).

c) All spare auxiliary contacts of the circuit breaker shall be supplied wired upto terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm2 copper conductor.

d) All wiring termination on terminal blocks shall be made through lugs.

e) All wires shall be identified with non-metallic sleeve or tube type markers at each terminations.

f) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers. Disconnecting type terminal blocks will be provided.

v) GROUNDING

A ground bus of copper bar not less than 6 mm by 25 mm shall be provided for grounding the cabinet.

4.10.18 ACCESSORIES

Each circuit breaker assembly shall be supplied with the following accessories.

i) Line and earthing terminals and terminal connectors.

ii) Control housing with:

a) One auxiliary switch with adequate number of auxiliary contacts, but not less than 20 nos. (10 NO + 10 NC) for each breaker. These shall be over and above the No. of contacts used for closing, tripping and re-closing and interlocking circuit of the circuit breaker. All auxiliary contacts shall be capable of use as “Normally closed” or “Normally open” contacts. Special auxiliary contacts required for the re- closing circuit if any, shall also be provided. There shall be provision, to add more auxiliary contacts at a later date, if required.

b) Operation counter

c) Position indicator (Close/Open)

d) Necessary cable glands

e) Fuses

f) Manual trip device and local test push buttons

g) Terminal blocks and wiring for all control equipment and

h) Adequate number of heaters for continuous operation to prevent moisture condensation in the housing of operating mechanism

i) Selector switch for local/remote control.

4.10.19 SUPPORTING STRUCTURE

The circuit breakers shall be supplied complete with necessary galvanized steel supporting structures, foundation and fixing bolts, etc., the galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be 3700 mm from finished ground level.

The bidder shall submit detailed design calculations and detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

4.10.20 SURFACE FINISH

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulation oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

4.10.21 GALVANISING

All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS:2629 or any other equivalent authoritative standard.

4.10.22 CABLE TERMINATION

Suitable cable glands for terminating the multicore cable, shall be provided wherever required.

4.10.23 TERMINAL CONNECTIONS AND EARTH TERMINALS

Each circuit breaker connected with incoming and outgoing feeders shall be provided with solderless clamp type connectors suitable for ACSR conductor.

Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

4.10.24 INTERLOCKS

Necessary interlocks to prevent closing or opening of the breaker under low pressure of the contact spring and devices for initiating alarm shall be provided. The detailed interlocking scheme based upon single line diagram as applicable for the substation shall be provided by the contractor

Requirement of interlock shall be as given below:

i) Isolator should not be operated unless the associated breaker is in open position.

ii) The circuit breaker shall close only after all isolators associated with it have been in closed position.

In case of double bus bar arrangement following additional requirement for interlocking shall be provided.

i) One bus bar selector isolator of any bay excepting the bus coupler bay shall close only when,

a) The circuit breaker of corresponding bay is open and locked.

b) The other bus isolator of that bay is open.

ii) When one bus isolator of any bay excepting the bus coupler bay is closed. The other shall close only when the bus coupler circuit breaker and both the bus isolators are closed.

iii) Bus isolator of bus coupler bay shall operate only when the bus coupler breaker is open.

iv) The bypass isolator of feeder shall close when the feeder circuit breaker and its adjoining isolators are closed.

4.10.25 EARTHING SYSTEM

All switchgear enclosures should be bolted metal to metal and should carry the full earth return current. Connection between phases at the earthing points shall be dimensioned for carrying full earth return current i.e., actual service current not rated current.

4.10.26 VACUUM INTERRUPTER ASSEMBLY

Each pole of the circuit breaker shall be provided with vacuum interrupter, one for each phase, hermetically sealed for life and encapsulated by ceramic insulators. The interrupter shall be provided with steel chromium are chamber to prevent vaporized contact material being deposited on the insulating body. A further shield giving protection to the metal bellows shall also follow the travel of the moving contacts to seal the interrupter against the surroundings atmosphere.

It shall have high and consistent dielectric strength of vacuum unaffected by environment and switching operations. Bronzed joints should ensure retention of vacuum for life time. It shall have low and stable contact resistance due to absence of oxidation effects and shall ensure low power loss. The arcing voltage shall be low and minimum contact erosion.

4.10.27 GUARANTEED TECHNCIAL PARTICULARS

Guaranteed and technical particulars as called for in Section-II shall be furnished along with the tender. Particulars which are subject to guarantee shall be clearly marked.

4.10.28 TYPE TESTS

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No. 62271- 100

i) Short time and peak withstand current test .

ii) Short circuit breaking capacity and making capacity.

iii) Capacitive current switching test : Cable charging current breaking test(Ur less than or equal to 52

kV).

iv) Dielectric test i.e., power frequency withstand and impulse withstand test

v) Temperature rise test.

vi) Mechanical Endurance Test at ambient temperature.

vii) Measurement of resistance of the main circuit.

ROUTINE TESTS

Routine Tests as per IEC- 62271-100 shall be carried out on each breaker in presence of purchaser's representative at the manufacturer's expenses at his works except, where agreed to otherwise. All test reports should be submitted and should be got approved from the purchaser before despatch of the equipment.

SITE TESTS ON CONTROL AND AUXILIARY CIRCUIT

The following tests shall be conducted at site.

i) Voltage tests on control and auxiliary circuit.

ii) Measurements of resistance of the main circuit.

iii) Mechanical Operation Tests.

4.10.29 NAME PLATE

Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant ISS or other specification stipulated.

4.10.30 TECHNICAL PARAMETERS 36 KV CIRCUIT BREAKERS

SL. NO.	DESCRIPTION	VALUES
i)	Rate voltage (KV rms)	36 KV
ii)	Rated frequency (Hz)	50
iii)	System neutral earthing	Solidly grounded system
iv)	Type of arc quenching medium	Vacuum
v)	Rated normal current at site conditions (Amps)	1250 Amps
vi)	Number of poles	3
vii)	Installation	Outdoor type
viii)	Temperature rise	As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit a) Interrupting capacity at 36 KV b) The percentage DC components c) Duration of short circuit	 25 KA As per IEC-62271-100 1 Sec.

x)	Rated short circuit making	62.5 KA
xi)	First pole to clear factor	1.5
xii)	Rated short time current	25 KA
xiii)	Rated duration of short circuit	3 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	< 80 ms
xv)	Closing time (ms)	< 150 ms
xvi)	Mounting	Hot dip galvanized lattices steel support structured bolted type
xvii)	Phase to phase spacing in the switch yard i.e., interpole spacing for breaker (min) in mm	470±10
xviii)	Required ground clearance from the lowest line terminal if both the terminals are not in same horizontal plane (mm)	3700
xix)	Height of concrete plinth (mm)	150
xx)	Minimum height of the lowest part of the support insulator from ground liner (mm)	3194
xxi)	Minimum creepage distance of support insulator (mm)	1116
xxii)	Minimum corona extinction voltage (kv rms)	92
xxiii)	Standard value of rated transient recovery voltage for terminal fault	As per IEC-56
xxiv)	Standard value of rated line Characteristics for short line faults RRRV	KV/ms=0.214
	Surge Peak Factor	K=1.6 A
	Impedance	450
xxv)	Rated operating duty cycle	O-0.3 Second- CO-3 Minutes-CO
	b) Auto reclosing	Suitable for three phase Auto reclosing duty
xxvi)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightening Impulse withstand voltage (KV peak)to earth	170 KV

xxvii)	Power frequency withstand voltage KV (rms) to earth (KV rms)	70 KV
xxviii)	Rated characteristic for out of Phase breaking	
	a) Out of phase breaking capacity	25% of rated breaking capacity
	b) Standard values of transient recovery	As oper IEC-56
	c) Operating mechanism	Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	Three phase 415 Volts 50 C/S or single phase 50 C/S 240 volts
xxix)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	1) 220 V DC/30 VDC
		2) 240 Volts AC 50 C/S single phase
		3) 415 volts 50 Hz three phase
	b) Permissible voltage variation	1) In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage.
		2) In case of AC power supply voltage variation shall be of the normal voltage as per IS-15% to +10%.
	c) Permissible frequency	3% from normal 50 Hz as per IS 2026 part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	10%
xxx)	Auxiliary contacts (number & rating)	12 NO and 12 NC on each pole having continuous current rating of 10 Amps. DC breaking rating capacity shall be 2 Amps with circuit time constant less than 20 ms at 220/30 volts DC
xxxi)	Number of trip coils	Two trip coils and 1 close coil with anti-pumping arrangement
xxxii)	Rated terminal load	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces
xxxiii)	Noise level of the equipment	Not exceeding 140 db

4.10.31 **DRAWINGS AND INSTRUCTION MANUALS**

Following drawings for each item are to be supplied as part of the contract.

i) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.

ii) Outline drawing of bushings showing dimensions and number of sheds and creepage distance.

iii) Assembly and sub-assembly drawings with numbered parts.

iv) Sectional views showing the general constructional features, operating mechanism and are extinguishing chamber, etc.

v) Dimension and assembly of important auxiliaries.

vi) Detailed drawings of operating mechanism. And inter-phase mechanism.

vii) Test certificates.

viii) Detailed drawings of mounting structure.

ix) Spare parts and catalogue

x) Wiring diagram showing the local and remote control scheme of breaker including alarms indication devices instruments relay and timer wiring.

xi) Write up on working of control schematic of breaker.

xii) Foundation plan including weights of various components and impact loadings for working foundation design. Three copies for each pkg. of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.

4.11.0 CONTROL & RELAY PANELS

This Section is intended to cover the design, manufacture, assembly, testing at manufacturer's works of Indoor Relay and Control Panels.

The Control and Relay Panels required are for control and protection of the Power Transformers, Feeders and for others according to requirements. The supply shall include all accessories, special tools, relevant software, supporting steels, spare parts, drawings, instruction manuals etc. The panels shall be supplied complete with all accessories as specified and completely assembled and all internal wiring completed.

The sub-stations will have automation as per guidelines of IEC 61850. The contractor has to supply the C&R panels to match the requirement of Sub-station Automation System (SAS) as specified in the subsequent chapter.

RELAYS

GENERAL

All relays shall conform to the requirements of IS 3231/IEC 60255/ IEC 61000 or other relevant Standards.

All protective relays shall be numerical type and communication protocol shall be IEC 61850. Further, test levels of EMI as indicated IEC 61850 shall be applicable to these relays.

Two sets of relevant software for relay configuration & setting, maintenance etc to be supplied to each station. The numeric relay and software shall be upgradable.

Relays shall be suitable for flush mounting with connectors from rear.

All draw out cases or plug in type modular cases will have proper testing facilities. The testing facilities provided on the relays shall be specifically stated in the bid. Necessary test plug shall be in the CONTRACTOR's scope of supply and shall be supplied loose. Unless otherwise specified all auxiliary relays and timers shall be supplied either in non-draw out cases or plug in type modular cases.

All A.C. relays shall be suitable for operation at 50 Hz. A.C. Voltage operated relays shall be suitable for110 volts VT secondary. DC auxiliary relays and timers shall be designed for 110 volts/ 220 volts DC and shall operate satisfactorily between 70% and 110% of rated voltage.

All Protective relays, auxiliary relays and timers except the lockout relays and interlocking relays shall be provided with self-reset type contacts. All protective relays, trip relays and timers shall be provided with electrically reset positive action operation indicators provided with proper inscription. Similar separate operating indicators (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholz relays, temperature protection etc.

No control relays that shall trip the circuit breaker when the relays are de-energized shall be employed in the circuits.

All relays shall withstand a test voltage of 2.5 kV, 50 Hz rms. voltage for one second.

All protective relays and alarm relays shall be provided with two extra isolated pair of contacts wired terminals exclusively for Employer's use.

GENERAL SPECIFICATION OF NUMERICAL RELAYS

Numerical Relays shall be provided for the following **applications** :

Distance Protection (Main I¬ & Main II) of different make for 220 kV lines
Distance Protection for 132 kV and 66 kV Lines
Back up directional over current and earth fault relays for 132 kV and 66 kV Lines
Back up non directional over current (3 O/C) and earth fault relays for 33kV lines
Integrated Numerical Transformer Protection
Back up non directional over current (3 O/C) and earth fault relays with high set units for power & auto transformers.

All **Numerical Relays** should have following **minimum features**.

- Relays shall be communicable on **IEC61850** protocol without any protocol converter. Certificate from KEMA confirming interoperability, ***Goose messaging & publishing as per IEC61850*** standard shall be submitted along with the tender.
- Relays shall have one no. front RJ45 or USB port for Local Relay Parameterization and **Two nos. rear FO port**/ Rear RS485 for connectivity to SAS over IEC61850 protocol
- The relay shall have self-communication port monitoring feature and failure shall generate alarm. Relays shall have redundant power supply card i.e. in case of failure of one source fail, the redundant shall pick up instantly. Power supply card failure shall generate necessary alarm to local SCADA.
- The relay shall have sufficient battery back up to keep the internal clock running for atleast 2 years in absence of auxiliary supply
- Should have minimum 16 configurable LEDs
- Should have sufficient Binary Inputs and Binary Outputs as per scheme requirement including 30% BI & BO spare.
- All BI/BOs shall be site configurable
- Shall have front minimum 4 lines LCD display with Alpha numeric key pad
- Numerical relays are to be provided with built in Event / Disturbance / Fault Recorder features. The bidder shall bring out in the bid that the Numerical relays providing different protection features / application in a single unit if any one of the application/features goes out of service the other feature/application (s) will remain un-effected.
- **The relays shall be site configurable (Including logic development)**
- Configured features & set values shall be in non-volatile memory Must have real time clock for time stamping of events/ disturbances with time synchronization inputs (GPRS etc.), Time synchronization through SNTP & IRIG-B compatible.
- The relays should have self-diagnostic features identifying area of fault or failure of a particular component or card.
- Shall have in built Circuit Breaker Failure protection based on undercurrent detection and/or circuit breaker auxiliary contact status. Provision shall be given to initiate the breaker fail logic using a digital input from external protection devices.

Hardware based measurement shall not be acceptable.

The relay should have high immunity to electrical and electromagnetic interference.

The same relay shall be provided with both 1A CT inputs and shall be site selectable.

It shall be possible to energise the relay from either AC or DC auxiliary supply. ***Auxiliary dc supply shall be suitable for both 110 and 220 Volt and shall be site selectable***.

Be capable of performing basic instrumentation functions and displaying various instantaneous parameters like Voltage, current, active power, reactive power, phase sequence etc. in primary values. Additionally, all sequence current and voltage values shall be displayed on-line. Also, the direction of power flow shall be displayed.

Extensive disturbance recording facility shall be available for at least up to 10 seconds to capture maximum possible information. Necessary software shall be provided for retrieving and analysing the records.

Facility for developing customized logic schemes inside the relay based on Boolean logic gates and timers should be available. Facility for renaming the menu texts as required by operating staff at site should be provided.

Must have additional feature of local breaker back up protection

- The relay shall have built in Circuit Breaker Supervision Functions
- The relay shall be able to detect any discrepancy found between NO¬ & NC contacts of breaker
- The relay shall monitor number of breaker trip operations
- The relay shall also monitor the breaker operating time

The relays shall have the following tools for fault diagnostics-

- Fault record – The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters. Event record – The relay shall have the facility to store time stamped event records with 1ms resolution.
- Disturbance records – The relay shall have capacity to store disturbance records of at least 10 sec. duration and sampling rate per cycle shall be more than 100.
- It shall be possible to preserve stored information in the event of an auxiliary supply failure with the help of a battery backup.
- The relay settings shall be provided with password protection.
- It shall be possible to change the relay setting from the front panel using the key pads/ Work¬ station of SAS and Laptop.

The relay shall have comprehensive self-diagnostic feature. This feature shall continuously monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated through an output watchdog contact. The fault diagnosis information shall be displayed on the LCD. These records shall also be retrieved / retrievable from local as well as remote terminal through the communication port.

The Numerical Relays shall be provided with 2 sets of common support software compatible with, Windows 7 which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, and measurements. The relay settings shall also be change from local or remote using the same software**.**

The manufacturer shall have to provide up-graded support software if any within 10 years span**.**

INTEGRATED NUMERICAL TRANSFORMER PROTECTION RELAY

General requirements

a) Shall be stable during magnetising inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents.

b) Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
c) Shall have zero sequence current filtering, which may be deactivated separately for each winding, for special applications.
d) Shall have software to take care of the angle & ratio correction of CT inputs.
e) Shall have all output relays suitable for both signals and trip duties

Functional Descriptions
The integrated Numerical Transformer Protection Scheme shall have following functional qualities: -

a) **Differential protection**

The relay shall be biased differential protection with triple slope tripping characteristics with faulty phase identification / indication. The range for the differential pick-up shall be from 0.1 to 2.5 p.u. Its operating time shall not exceed 30 ms at 5 times rated current.

The relay shall have two adjustable bias slopes from 20 % to 150 % and slope from 40% to 150 %, to provide maximum sensitivity for internal faults with high stability for through faults.

The relay shall have an unrestrained high set element to back up the biased differential function and the setting range for it shall have a minimum setting of 5pu and a maximum setting of 30pu.

The relay shall have the second harmonic restraint feature for stability under transformer inrush condition. The setting shall be 15-25%.
Further, the fifth harmonic blocking for stability under transient over fluxing condition shall be provided.

b) **Restricted Earth fault Protection**

The scheme shall have in-built restricted earth Fault (REF) for both the windings. This function should be provided to maximise the sensitivity of the protection of earth faults.

The REF function should be a high impedance element. The REF function should be able to share Current Transformers with the biased differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents.

For star/star transformer, both the windings shall be protected through REF, as such relay shall have sufficient analogue channels to accommodate the same.

c) **Over fluxing Protection**

The over fluxing protection shall be built in the relay. By pairs of v/f and t, it shall be possible to plot the over fluxing characteristics so that accurate adaptation of the power transformer data is ensured.
In addition the relay should have a definite time element for alarm.

d) **Thermal Overload Protection**

Shall have two stages of thermal overload protection for alarm and trip condition with continuously adjustable setting range of 100-400% of rated current and time constant setting range of 1.0 to 1000.0 min continuously.
Shall be single pole type.
Shall have a drop off/pick up ratio greater than 95%

Shall have separately adjustable time delay relays for alarm having a setting range of 1to 10 seconds continuously.

e) **Over Current Protection**

The relay shall have three stages of definite time over current protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current.
In addition, the relay shall have three stages of Inverse time over current protection operating based on one measuring system each for the three phase currents, the negative sequence current and the residual current.
f) Shall have additional features to provide **under/ over voltage protection.**
g) Shall have additional features to provide **under frequency protection.**

OVER CURRENT AND EARTH FAULT RELAYS

These relays shall be of numeric, single/multi pole, directional /non-directional type with or without high set element as specified. These relays shall have the following features/characteristics:
(i). IDMT characteristic with definite minimum time of 3 second at 10 times setting.
(ii). Other operating curves such as inverse, very inverse shall be selectable
(iii). Adjustable setting range of 50-200 % and 20-80% of rated current for over current and earth fault relays respectively.
(iv). The directional relays shall have a Maximum torque angle of 45° current leading for directional over current unit & 30 lag for directional earth fault. Other MTAs should be settable
(v). Voltage polarizing coil: 63.5 or 110 volt
(vi). Must have faulty phase, type of fault identification
(vii). The directional relays shall have over voltage/ under voltage & under frequency built in protection
(viii). The relay shall have blocking scheme on Reverse Power Flow.
(ix). Shall be draw out type

TRIP CIRCUIT SUPERVISION RELAY

The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
The relay shall have adequate contacts for providing connection to alarm and event logger.
The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

MASTER TRIP RELAY
High Speed Tripping Relay shall be instantaneous (operating time not to exceed 10 milli-seconds)
The relays shall reset within 20 milli seconds
The relay shall be re-settable/configurable from local SCADA.
The relays shall be D.C. operated
The relays shall have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc
The relays shall be provided with operation indicators for each element/coil.

OTHER TRIP RELAYS

For transformer protection other trip relays for Buchholz, winding & oil temperature high, PRD etc. shall be provided as per requirement.
These High Speed Tripping Relays shall be instantaneous (operating time not to exceed 10 milli-seconds
The relays shall have adequate contacts to meet the requirement of scheme

DC SUPPLY SUPERVISION RELAY
The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
It shall have adequate potential free contacts to meet the scheme requirement.
The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and
The relays shall be provided with operation indicator/flag.

PROTECTION SCHEME FOR PANELS

33 KV FEEDER PROTECTION PANEL

The 33 kV Feeder Panels shall be provided non directional single/ multi pole relays as specified

One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided.

POWER AND AUTO TRANSFORMER PROTECTION PANEL

The following protections scheme shall be provided for Panels for all Power and Auto Transformers:

(a) **Main Protection**
Biased transformer differential protection employing relay type specified. As overall protection scheme for transformers following features of the Numerical Relay shall be employed:
(i) Restricted Earth Fault Protection.
(ii) Over-fluxing protection
(iii) Under Frequency and Over Voltage Protection

(b) **Backup Protection**
The backup protection shall be provided with non-directional relays as specified. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided. The high set unit should not operate due to transformer in-rush current.

SWITCHES

Control and instrument switches shall be rotary operated type with plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out. Handles of different shapes and suitable inscriptions on switches shall be provided as on switch identification
The selection of operating handles for the different types of switches shall be as follows:-
(a) Breaker and isolator - Pistol grip, black control switches.
(b) Synchronizing switches-Oval; black, keyed handle.
(c) Selector switches - Oval or knob; black
(d) Instrument switches - Round, Knurled, black.
(e) Protection transfer - Pistol grip; lockable and black switch.

The control switch of breaker and isolator shall be of spring return to neutral type.

Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selector switches shall have make before type contacts so as to prevent open circuit of CT secondary when changing the position of the switch.

Synchronising switches shall be of maintained contact type having a common removable handle for a group of switches. The handle shall be removable only in the OFF position and it shall be arranged to the 'ON' position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the 'ON' position.

The contacts of all switches shall preferably open and close with snap action. Contacts of switches shall be with coated with pure silver. Spring shall not be used as current carrying parts.

TESTS

The supplier shall carryout all tests as per relevant standards as all associated equipment including relays, meters, instruments etc. The supplier shall submit all that reports to Employer for approval before despatching the control and relay panels. The Bidder shall also submit along with the bid type test reports for relays instruments, meters and other devices of the type and class being offered. Bidder has to submit KEMA test certificate for Numeric relay on interoperability compliance of IEC 61850 in general and GOOSE messaging and publishing in particular along with the bid.

Control and relay panels shall be subjected to the following tests: a. Mechanical operation test.
b. Verification of degree of protection.
c. High voltage test (2000 volts for 1 minute)
d. Electrical control interlock and sequential operation test.
e. Verification of wiring as per approved schematic.
f. Interoperability test as per IEC 61850 (interoperability with ABB, AREVA, SIEMENS, GE and SEL)

PRE-COMMISSIONING TESTS

The contractor shall have to perform following minimum Pre-commissioning tests, as applicable, for commissioning of the C&R panels. For this purpose, the contractor shall arrange all required tools and testing equipment at site.
(i). IR values of all circuits.
(ii). Measurement of burden in CT & PT circuits.
(iii). Primary current injection of CT circuits with connected burden
(iv).Energisation of PTs at suitable low voltage and measurement of PT inputs at all measuring points
(v). Secondary ac current injection of relays, dynamic testing of all numeric relays. Tracing of zone curves, limits. Checking of relay timings, inherent or set values. For this testing, the contractor shall bring 'Omicron' or equivalent test kit.
(vi).Testing of voltage related elements like directional element, over fluxing, over/ under frequency, over/ under voltage features, tracing of curves and checking limits of set values and associated timings
(vii). Checking of Boolean logic gates, BI/BO points of the numeric relays, checking conformity to specification and checking of set logics
(viii). Checking of stability and sensitivity of differential zones by suitably applying 3-phase low voltages and shorting of primary circuits. Measurements of voltage and current inputs to all relays.
(ix). Checking stability & sensitivity of bus differential relay zones by suitably injecting current
(x). Primary injection of REF connected CTs, measurements of relay inputs and checking of stability and sensitivity of REF scheme

(xi). Checking registration of event and disturbance records in the numeric relays and downloading
(xii). Testing of carrier aided protection schemes and simulation with regard to transmission and receipt of protection signalling
(xiii). Testing of AR schemes.
(xiv). Checking of healthiness of each dc circuit of panels
(xv). Simulation of faults like Buchholz, OTI, WTI and other relays and checking of tripping of breaker and connected annunciation
(xvi). Operation of master trip relays, tripping of breaker through each trip coil and checking of inter locks
(xvii) Simulation of faults like low gas, air pressure and checking operation of inter locks. Checking anti umping scheme of CB.
(xviii).Simulation to Check Checking of PT selection schemes
(xix). Simulation to Check interlocks of all CB and isolator inter locks
(xx). Simulation to Check annunciation of all events in BCU (Bay control unit) as well as SAS (Substation automation System)
(xxi). Simulation to Check of logic of BCU.
(xxii). Operation of tap changing of transformer through SAS

TECHNICAL DATA SHEET FOR THE RELAY AND CONTROL PANELS

Features to be provided in various Relay and Control panels are indicated below.
Description below are only indicative; the Contractor shall ensure that all items are included in their off to complete the schemes described in the Specification whether such items are specifically mentioned or not.

SL NO	Item	Ratings & particulars
1	**Protection and Relays**	
	a) Back up directional over current and earth fault scheme	1 set
	b) LBB protection Scheme.	Can be function of BCU/IED's
	c) Trip Circuit supervision Relay for pre and post-closing	Supervision for 02 trip coils
	d) DC Supply healthy monitoring scheme	1 No
	e) AC Supply healthy monitoring scheme	1 No
	f) High Speed Trip relay	2 Nos.
	g) Auxiliary relay, timer relay for healthiness of relays, trip transfer, auto reclose communication link etc. As required	As required (Can be function of BCU)
	h) Bus PT selection scheme	1 No
2	**Control/Status indication/annunciation**	
	a) Bay Control Unit (IED with HMI)	1 No (Function of BCU/SAS)
	b) Ethernet switch for connecting to existing ring LAN of SAS	1 No

4.12.0 GENERAL SPECIFICATION OF WORK:

The work is to be executed as per specifications of the BOQ as provided by AEGCL. Any unauthorised deviation is strictly prohibited and any deviation is to be corrected by the contractor at his own risk and cost.

SITE PREPARATION: -

All the works related to dismantling, demolishing of existing structure has to be carried out by the contractor at their own costs as per direction of AEGCL. And all the dismantled and demolished unserviceable material has to be disposed off by the contractor outside the AEGCL premises and serviceable materials to be stacked as per the directions of AEGCL officials.
The Contractor shall clear the site of vegetation by felling of trees, uprooting of stumps etc. to prepare the site for work only as per directions given by the Site Engineer
The Contractor will have to construct access or any means for transport of material as per site requirements if the site is not easily accessible.
All water which may accumulate on the site before or during the progress of the works or in trenches and excavations shall be removed and drained out from the site to the satisfaction of the Site Engineer by the Contractor.
Any other work required for adequate preparation of the site for construction deemed necessary shall be carried out by the Contractor.

EARTHWORK IN EXCAVATION: -
Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming, dewatering etc. and removal of surplus earth with all lead and lifts as directed and specified including bailing out water where necessary as directed and specified.

BRICK SOLING: -
Brick soling in foundation and under floor should be provided with best quality jhama bricks as approved by Site Engineer.

PLINTH WALL AND PLINTH FILLING: -
The plinth wall shall be thick brick/stone masonry works in cement mortar prop. 1:3 with cement plaster prop.1:4 on exposed faces with neat cement finishes. The outer plinth wall shall be 230mm thick and inner plinth wall shall be 112 mm thick.
Sand filling in plinth (height= 600mm) is to be done using suitable river sand or silt in layers not more that 150mm thick including all necessary watering, ramming, compaction etc. as directed by the Site Engineer.

PLAIN CEMENT CONCRETE WORKS: -
Plain Cement Concrete works must be carried out with coarse aggregates of sizes 13mm to 32mm in dry condition and dewatering should be carried out wherever necessary before placing of concrete.
The proportion of Plain Cement Concrete should be 1:3:6 or as specified in the drawing and design. The quality of the mix will have to be checked and approved by the Site Engineer.
Curing should be done properly and as per instructions of AEGCL.

DAMP PROOF COURSE: -
Damp proof course of 25mm thickness is to be applied above the plinth wall with cement concrete in proportion 1:1.5:3 with graded stone aggregate of 10mm down nominal size including damp proof admixture in proportion as per direction of Site Engineer. Water proof cement additive shall conform to IS 2645.

ANTI-TERMITE TREATMENT: -

Pre construction anti - termite treatment should be applied at the bottom of foundation pits and walls on either side up to a height of 300mm from bottom of the excavation made for column plinth beam, wall, trenches etc. by applying the emulsion @ 5 (five) litres per square meter of the surface area before starting construction work (supplying of necessary tools and accessories by the contractor) as per the direction of the Department.

REINFORCEMENT: -

The Contractor shall procure all reinforcement steel required for the works, only from the primary producers manufacturing steel to the prescribed specifications of Bureau of Indian Standards or equivalent and licensed to affix ISI or other equivalent certification marks and acceptable to the Engineer-in-Charge. Necessary ISI list certificates are to be produced to Engineer-in-Charge before use on works. The unit weight and dimensions shall be as prescribed in the relevant Indian Standard specification for steel.

All reinforcement shall be cleaned thoroughly by removing loose scales, oil, grease or other deleterious materials. The contractor shall obtain the approval of the Engineer-in-charge or his representative to the reinforcement when fixed in position before any concrete is deposited in the forms.

Bars shall be bent cold or straightened in a manner to the satisfaction of the Engineer-in-charge or his representative. Bars bent during transport or handing shall be straightened before using on work. They shall not be heated to facilitate bending. Welding shall be done as per latest IS Code of practice.

All reinforcement bars shall be cut and standard hooks for MS rounds made at ends and accurately placed in position as shown on the approved drawings. They shall be securely held in position before and during concreting by annealed binding wires used for binding the reinforcement which shall be of approved quality soft annealed iron wire not less than 1 mm (18SWG) size, conforming to IS:280.

As far as possible, bars of full length shall be used. Where bars are required or permitted to be lapped by the Engineer-in-charge, or his representative, the over laps shall be staggered for different bars and located at points, along the span where bending moment is not maximum.

The minimum grade of reinforcement to be used is Fe500.

SHUTTERING AND SHORING: -

Shuttering and shoring works is to be done with timber planks of 25mm thickness wherever necessary including removal of the same for in-situ reinforced/plain cement concrete works.

When the Shuttering is ready for commencing concreting, the Engineer in Charge shall check the shuttering work for their alignment, strength and general fitness.

If the Site Engineer is satisfied with the quality of shuttering, then may allow the contractor for pouring concrete. Poor or old shuttering should not be used. The Site Engineer at his own discretion may reject any shuttering material if found not satisfactory.

BRICK MASONRY: -

Brick work in cement mortar with 1st class brick including racking out joints and dewatering if necessary, and curing complete as directed by Engineer in-charge. Cement Mortar used should be in 1:4 proportion.

The thickness of the masonry walls in superstructure shall be 112mm.

The thickness of the walls shall be as per the approved drawings.

REINFORCED CEMENT CONCRETE: -

RCC works in footings, Tie- beam, lintel. Roof-beam, Column, Slab, Chajja etc. should be done using M20 grade concrete (prop 1:1.5:3).

Curing shall be done as per IS 456:2000 under the supervision of the Site in-charge.

Cube moulds shall be prepared for concrete strength tests as per relevant IS codes. For Cube testing three nos of cube moulds each should be prepared for testing during the following stages of construction: -

(a)Footing

(b)Column
(c)Beam/Slab

The cube tests should be done to test the strength after 28 days.

Cube moulds should be prepared for destructive testing randomly as per instructions giver by Site Engineer.
Optimum quantity of water shall be mixed to produce the design mix/nominal mix concrete of required workability.
Workability shall be such that the concrete surrounds and properly grips all reinforcement.
The degree of consistency, which shall depend upon nature of work and method of vibration of concrete, shall be determined by regular slump tests to be carried out by the contractor at his cost.
Usually for mass concrete in RCC works where vibrations are used the slumps shall be within 10mm to 25mm.
The frequency of such tests and the natures of slumps shall be maintained within the limits specified by the Engineer-in-charge.
The Engineer-in-charge also reserves the right to carry out slump tests independently at his own discretion.
Cement shall have to be weighed from bulk stocks at site and not by bags. It shall be weighed separately from the aggregates.
Water shall either be measured by volume in calibrated buckets or weighed. All necessary equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.
Honeycombed RCC structure should be dismantled immediately and reconstructed.
The mixing shall be done by mechanical means using mixer machine.

CEMENT: -

The cement to be used shall be the best quality of its type.
All cement shall be sampled and tested in accordance with Indian Standards.
Cement shall be Ordinary Portland Cement as per I.S.269-1976 or Portland Pozzolona Cement as per I.S. 1489. The minimum grade of the Ordinary Portland cement to be used shall be OPC-43 grade and it shall confirm to IS 269.
Delivery and storage of cement- Cement shall be delivered to the site in bulk or in sound and properly sealed bags and while being loaded or unloaded whether conveyed in vehicles or by mechanical means, and during transit to the concrete mixers, must be protected from the weather by effective coverings. Efficient screens are to be supplied and erected to prevent wastage of cement during strong winds. If the cement is delivered in bulk, the Contractor shall provide at his own cost approved silos of adequate size and number to store sufficient cement to ensure continuity of work. The cement shall be placed in these silos immediately it has been delivered on the site. Suitable precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance.
The cement must be used within 3 months from the date of manufacture.

CURING: -

Curing should be done as soon as possible after concrete is placed and when initial set has occurred and before it has hardened. It should be continued for a minimum period of 7 to 12 days when ordinary (Portland) cement is used, 4 to 7 days when rapid hardening cement is used, and should be kept thoroughly wet for 24 hours when high alumina cement is used.
Vertical surfaces may be covered with hanging curtains. Columns and small members shall be cured by wrapping round them wet sacks or by sprinkling water continuously. On vertical surfaces it should be checked that the wet fabric is in contact with the surface.
Water should be sprinkled on the underside of beams and slabs for proper curing.

PLASTERING: -

Surfaces to be rendered must be cleaned and made free from all dust, loose materials, grease, etc, and be well wetted for a few hours (the wall should not be soaked but only damped evenly); but the wall should not be too wet.Plaster work on new construction should be deferred as much as possible so as to let shrinkage in reinforced concrete and masonry take place before plastering. General proportion for cement plaster should be 1:4.

PLINTH PROTECTION WORKS: -

Plinth protection should be provided with bricks laid on edge and grouted with cement mortar 1:4 and finishing with cement pointing in prop 1:1 complete with a floating coat of neat cement finished.
The plinth protection shall be provided upto a width of 500mm from the plinth wall.

PLINTH DRAINAGE: -

Drainage should be provided with brick work in cement mortar in proportion 1:5 with half brick side walls and 100mm thick C.C (1:3:6) base over one brick flat soling including 15mm thick cement plastering in prop. 1:3 finished with a floating coat of cement slurry as directed with necessary shuttering for sides and earth work in excavation of foundation trenches and refilling the sides after completion of work etc. as specified. (The size of drain should be minimum 300 mm wide and average 150 mm deep with bed slope 1 in 150 with initial depth of 100 mm.)

CEMENT PLASTER SKIRTING (FOR OUTER PORTION OF THE PLINTH WALL): -

The outer portion of the plinth wall is to be provided with cement plaster skirting with cement mortar in prop 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement including rounding of junctions with floor of 15mm thickness.

RETAINING WALL: -

Stone masonry work in retaining wall, wing wall, abutment, foundation, steps, plinth etc. in cement mortar in prop 1:6 with levelling course of 1:6:12 with both faces hammer dressed including bonding, providing face stone, through stone and centering including racking of joints, curing and supplying and all carriage of stone as directed including payment of forest royalty and sales tax and carriage.
50 mm dia PVC pipes shall be provided for weep holes @1.00 m interval on staggered manner as directed by the engineer in charge.

PAINTING ON STEEL SURFACES: -

All steel surfaces should be painted with one coat of primer and two coats of enamel paint.

Note: All other specifications shall be as per the approved drawings.