BIDDING DOCUMENT

FOR

Construction of 220 KV GIS Bay at Sonapur GIS

Volume 2

ASSAM ELECTRICITY GRID CORP. LTD.

Tender Fee: ₹ 5000/-

BID IDENTIFICATION NO:

AEGCL/MD/Tech-291/Bid/bay(R)

Construction of 220 KV GIS Bay at Sonapur GIS

BIDDING DOCUMENT

Section-1
SCOPE AND GENERAL TECHNICAL CONDITIONS

1.1.0 INTENT OF THE SPECIFICATION

1.1.1 This volume of the specification deals with the general technical information & criteria for design, manufacture, supply & delivery of equipment/material, erection, testing & commissioning and setting to work of construction of new 220kV Bays on "Design, Supply and Install" basis as defined in Volume-1.

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

1.2.0 SCOPE

1.2.1 The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site subsequent storage and erection & commissioning at site of various equipment and materials as per BOQ. Technical specifications of many equipment are provided in the bid. However, the bidders are requested to only check the equipment required for the bay.

1.2.2 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 judgement is not in full accordance therewith.

1.2.3 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) 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.
iii) Supply and erection of substation/ equipment mounting steel structure.
iv) Construction of cable trenches and earth mat including supply of all materials.
v) Other works includes site development, construction of equipment and structure foundations, supply & installation of Security Fencing (dismantling a part of the existing fencing and construction of new fencing as brought out in the Bill of Materials), Design and installation of illumination system for switchyard (for the 220 KV bay under construction vide this BID) etc. as brought out in the Specification and Schedule of Requirements.
vi) SAS Integration is excluded from the present scope. However, necessary cabling between LCC panels and CRP panels shall be under the scope of the bidder.
vii) The new GIS bay may be connected to far end side from GIS hall entry or on the side towards the existing control room. Further, details will be provided during detailed engineering.
viii) The following shall be finalized during Detail Engineering / Site Visit by the bidder: -
    1. Trench and dismantling works
    2. Soil investigation & earthing details
    3. GIS section view and Gas SLD
    4. EOT crane layout and structural details

1.2.4 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.

1.2.5 The tentative Bill of Quantities is furnished in Section 2: BIDDING FORMS of Vol-1 of this Bidding Document.

1.3.0 CONTRACTOR TO INFORM HIMSELF FULLY

1.3.1 The Contractor 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.

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

1.4.0 SERVICE CONDITIONS

1.4.1 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□C
b)	Minimum night temperatures		0□C
c)	Reference ambient day temperature		45□C
d)	Relative Humidity	(a)Maximum	100 %
		(b)Minimum	10 %
e)	Altitude		Below1000 M above MSL
f)	Maximum wind pressure:		As per IS: 802 latest code
g)	Other Data		Refer Meteorological data pertaining to the locations
h)	Seismic Intensity		ZONE-V as per IS 1893.

1.5.0 **CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS**:

1.5.1 The CONTRACTOR 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.

1.6.0 STANDARDS

1.6.1 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.

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

1.6.2.1 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.

1.7.0 CONTRACTOR'S REQUIREMENT

1.7.1 The Contractor should be in possession of a valid E.H.V. Electrical Licence issued by the Chief Electrical Inspector, Govt. of Assam, as per the provision of Law. An attested copy of the aforementioned Licence must be handed over to the Employer for his record prior to handing/ taking over of sites.

1.7.2 All the works shall also be inspected by the Chief Electrical Inspector, Govt. of Assam or his authorised representatives. It is the responsibility of the Contractor to obtain pre-requisite commissioning clearance of any equipment from the said Inspectorate. The Contractor will pay necessary fees to the Inspectorate, which it may levy.

1.8.0 ENGINEERING DATA

1.8.1 The furnishing of engineering data by the CONTRACTOR 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 CONTRACTOR, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

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

1.9.0 DRAWINGS AND DOCUMENTS FOR APPROVAL

1.9.1 In addition to those stipulated in clause regarding drawings in GENERAL CONDITIONS OF CONTRACT (Vol-1), the following sub clauses shall also apply in respect of Contract Drawings.

1.9.2 All drawings submitted by the CONTRACTOR 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.

1.9.3 Each drawing submitted by the CONTRACTOR 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.

1.9.4 The drawings submitted for approval to the Purchaser shall be in quadruplicate. One print of such drawings shall be returned to the CONTRACTOR by the Purchaser marked "approved/approved with corrections", if found generally in accordance with the specifications.

1.9.5 Initial submitted drawings may be in soft copies forwarded through emails. However, in this case drawings must be in Auto-CAD.
The CONTRACTOR 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.
The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

1.9.6 All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. The contractor may make any changes in the design which are necessary to conform to the provisions and intent of the contractor and such changes will again be subject to approval by the Employer.

1.9.7 The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:
a) The Contractor has completed the part of the Works covered by the subject document (i.e., confirmation of progress of work).
b) The Works appear to comply with requirements of Specifications.
In no case the approval by the Employer of any document does imply compliance with neither all technical requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

1.9.8 All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be acceptable.
After final approval all the drawings shall be submitted to the Employer in readable CD's.

1.9.9 The following is the general list of the documents and drawings that are to be approved by the

Employer:

1.9.10 All Designs / Drawings / Calculations/ Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

1.10.0 FINAL DRAWINGS AND DOCUMENTS

1.10.1 The successful Contractor shall require to provide following drawings and documents for each

substation in printed form and as well as in soft copies. All soft copies of drawings must be in 'AutoCAD' file format.

(a) All approved drawings (AS BUILD) of equipment and works related to a particular substation in three (3) copies.
(b) Instruction manuals of all equipment related to a particular substation in three (3) copies. These instruction manuals shall generally consist of
    (i) Operation Manuals, (ii) Maintenance Manuals and (iii) Spare Parts Bulletins.
(c) Copies of routine test reports (in triplicate) of relevant equipment.
(d) Final Guaranteed and Other technical particulars of relevant equipment (in triplicate).

1.10.2 In addition to the above, the Contractor shall provide five (5) sets of all the printed drawings and documents including the soft copies to Employer for his reference and record.

1.11.0 APPLICATION AND SYSTEM SOFTWARE

1.11.1 Contractor shall provide copies of licensed copies application software / configuration & system software in the form of CD (in duplicate) for all IEDs, meters, SAS etc.

1.12.0 DESIGN IMPROVEMENTS

1.12.1 The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

1.13.0 DESIGN CO-ORDINATION

1.13.1 Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.14.0 DESIGN REVIEW MEETING

1.14.1 The contractor will be called upon to attend design review meetings with the Employer, and the consultants of the Employer during the period of Contract. The contractor shall attend such meetings at his own cost at Assam or at mutually agreed venue as and when required. Such review meeting will be held generally minimum once a month or the frequency of these meeting shall be mutually agreed between the Employer and the Contractor. Frequency of Design Review Meetings shall depend upon the project requirement to ensure project implementation as per the Master Programme.

1.15.0 QUALITY ASSURANCE, INSPECTION & TESTING

1.15.1 Quality Assurance

To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub Contractor's premises or at site or at any other place of work are in, accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. A quality assurance programme of the Contractor shall generally cover but not limited to the following:

a) His organization structure for the management and implementation of the proposed quality assurance programme
b) Documentation control System.
c) Qualification data for Contractors key personnel.
d) The procedure for purchases of materials, parts components and selection of sub-contractors services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
e) System for shop manufacturing including process controls and fabrication and assembly controls.
f) Control of non-conforming items and system for corrective action.
g) Control of calibration and testing of measuring and testing equipment.
h) Inspection and test procedure for manufacture.
i) System for indication and appraisal of inspection status.

j) System for quality audits.
k) System for authorizing release of manufactured product to the Employer.
l) System for maintenance of records.
m) System for handling storage and delivery and
n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply.

The Quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

1.15.2 Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material.
The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

1.16.0 EMPLOYER'S SUPERVISION

1.16.1 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.

1.16.2 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.
(f) Review and suggest modification and improvement in completion schedules from time to time, and
(g) Supervise the Quality Assurance Programme implementation at all stages of the works.

1.17.0 INSPECTION & INSPECTION CERTIFICATE

1.17.1 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 CONTRACTOR and their sub-CONTRACTOR(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.

1.17.1.1 All routine and acceptance tests whether at the premises or works of, the CONTRACTOR or of any Sub-CONTRACTOR, the CONTRACTOR 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 CONTRACTOR free of charge.

1.17.1.2 If desired by the Purchaser, the CONTRACTOR 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 CONTRACTOR 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.

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

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

1.18.0 **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 CONTRACTOR 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 CONTRACTOR and the Purchaser.

1.18.1 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 CONTRACTOR and the Purchaser in the Quality Assurance Programme.

1.18.2 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.

1.19.0 GUARANTEED TECHNICAL PARTICULARS

1.19.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in the prescribed schedules of this Specification with the Technical Bid. 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.

1.19.2 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.

1.20.0 PACKING

1.20.1 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 CONTRACTOR shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

1.20.2 The CONTRACTOR 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.

1.20.3 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.

1.20.4 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.

1.20.5 Each package shall be legibly marked by the-CONTRACTOR 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 CONTRACTOR etc.

1.21.0 CONSTRUCTION TOOLS, EQUIPMENTS ETC.

1.21.1 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.

1.22.0 MATERIALS HANDLING AND STORAGE

1.22.1 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.

1.22.2 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.

1.22.3 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.

1.22.4 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.

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

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

1.22.7 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.

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

1.23.0 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

1.23.1 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 thereto.

1.23.2 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.

1.23.3 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.

1.24.0 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.

SECTION-2
TECHNICAL SPECIFICATION FOR CONSTRUCTION WORKS IN SUBSTATIONS

2.1.0 GENERAL

2.1.1 *The intent of this Section of the Specification is to cover requirements which are to be followed in construction of switchyards including civil works in the switchyard.*

2.1.2 *The work shall be generally carried out as per approved drawings..*

2.1.3 *The above sets of drawings are tentative and may require modifications depending upon project, site conditions, exact equipment dimensions, etc. The Contractor shall be required to prepare his own drawings based on project with modifications as and if required and shall submit those for Employer's scrutiny*.

2.1.4 *Further, drawings are not complete sets of drawings normally required in similar type of installation. The contractor will be required to prepare the balance drawings and submit those for approval of Employer*.

2.1.5 *Only single diagrams are supplied for bus bar and equipment support structures (excluding mounting structures for Circuit Breakers and Isolators). The Contractor will be required to develop the fabrication drawings based on these SLDs and will submit those for approval of the Employer. As far as Mounting Structures of Circuit Breakers and Isolators are concerned it is responsibility of the Contractor to design the same as per this technical specification*.

2.2.0 SURFACE PREPARATION AND STONE SPREADING

2.2.1 Before taking up PCC base (pro-1:4:8) and stone filling at the location in the construction site, the area shall be thoroughly de-weeded including removal of roots as directed by the Engineer-in-Charge.

2.2.2 After all the structures, equipment & earthing system are erected and after construction of cable trenches, the surface of the switchyard area shall be maintained, rolled/ compacted to the lines and grades as decided by Engineer-in-Charge. De-weeding including removal of roots shall be done before rolling is commenced. Engineer-in-Charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the drawing using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface.

2.2.3 A base layer of PCC of 80 mm thickness with proportion of 1:4:8 shall be provided before spreading of crushed rocks. PCC base shall be done in panels of 4 m x 4 m with expansion gap of 25 mm between panels. The gap shall be filled with bitumen. Each panel shall be provided with four (4) numbers of PVC pipes (per panel) of 100 mm dia of length 450 mm for soaking of water. The pipes will be provided with gratings at the top and the same will be flushed with the PCC top.

2.2.4 Over the PCC layer, a surface course of minimum 100mm thickness of 20mm nominal size river pebbles or (single size ungraded) broken stone shall be spread.

2.3.0 CABLE TRENCHES AND CABLE TRAYS

2.3.1 Construction of cable trenches with pre-cast removal R.C.C cover (with lifting arrangement) as per

drawings supplied with the Bid Documents shall be carried out by the Contractor.

2.3.2 The Contractor shall provide embedded steel plates of adequate size on the walls of concrete cable trench for supports for cable trays. Insert plates will be provided at an interval of 2000mm.

2.3.3 If asked for, the cable trench walls shall be designed for following loads: -
(a) Dead load of 155 kg/M length of cable support (tray) + 75 kg on one tier at the end.
(b) Triangular earth pressure + uniform surcharge pressure of 2T/m2.

2.3.4 RCC cable trench cover shall be designed for self-weight of slab + UDL of 2000 kg/m2 + a concentrated load of 200 kg at center of span on each slab panel.

2.3.5 Cable trench inside the Control Room shall be covered with 6 mm thick chequered plates with lifting arrangement.

2.3.6 Cable trench crossing the road/rails shall be designed for class AA. Loading of IRC/relevant IS Code and should be checked for transformer loading.

2.3.7 Trenches shall be drained. Necessary sumps be constructed and sump pumps if necessary, shall be supplied. Cable trenches shall not be used as storm water drains.

2.3.8 All metal parts inside the trench shall be connected to the earthing system.

2.3.9 Cables from trench to equipment shall run in hard conduit pipes.

2.3.10 Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

2.3.11 The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

2.3.12 All the construction joints of cable trenches i.e., between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.

2.3.13 Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12 mm thick 1:6 cement sand mortar.

2.3.14 Cable Trays

(i). The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2 mm.
(ii). The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.
a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.
b) Deflection Test: (Type Test)
A 2.5 metre straight section of 300mm, wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

2.4.0 FOUNDATION AND RCC CONSTRUCTION

2.4.1 General

2.4.1.1 Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, control cubicles, bus supports, transformer, marshalling kiosks, auxiliary equipment and systems, buildings, tanks, boundary wall or for any other equipment or service and any other foundation required to complete the work.

2.4.1.2 Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification.
A minimum grade of M20 concrete shall be used for all structural/load bearing members as per latest IS 456.

2.4.1.3 If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of the structures to compensate for such slopes.

2.4.1.4 The switchyard foundation's plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

2.4.1.5 Minimum 75 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches, etc., to provide a base for construction.

2.4.1.6 Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

2.4.1.7 The design and detailing of foundations shall be done based on the approved soil data and subsoil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

2.4.1.8 If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

2.4.2 Design

2.4.2.1 All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20.
Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Employer.

2.4.2.2 Limit state method of design shall be adopted unless specified otherwise in the specification.

2.4.2.3 For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe- 415 N/mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

2.4.2.4 RCC water retaining structures like storage tanks, etc., shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method.

2.4.2.5 The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and or superstructure and other conditions, which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

2.4.2.6 Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

2.4.2.7 Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/ harmful to the concrete foundations.

2.4.2.8 RCC columns shall be provided with rigid connection at the base.

2.4.2.9 All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

2.4.2.10 Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable).
However, for the design of sub-structures of any underground enclosures, earth pressure at rest shall be considered.

2.4.2.11 In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, sub-structure of any underground hollow enclosure, etc., for the vehicular traffic in the vicinity of the structure.

2.4.2.12 Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:
a) Full water pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).
b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

2.4.2.13 The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

2.4.2.14 The foundations of transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

2.4.2.15 The tower and equipment foundations shall be checked for a factor of safety of 2.0 for normal condition and 1.50 for short circuit condition against sliding, overturning and pull out. The same factors shall be used as partial safety factor overloads in limit state design also.

2.4.3 Admixtures & Additives

2.4.3.1 Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

2.4.3.2 Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Employer shall approve concrete Admixtures/Additives.

2.4.3.3 The Contractor may propose and the Employer may approve the use of a water-reducing set retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations

and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

2.4.3.4 The water reducing set-retarding admixture shall be an approved brand of Ligno- sulphonate type admixture.

2.4.3.5 The water proofing cement additives shall be used as required/advised by the Employer.

2.5.0 SUBMISSION

2.5.1 The following information shall be submitted for review and approval to the Employer as far as Civil Works are concerned:

(a) Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.

(b) Structural design calculations and drawing (including constructions / fabrication) for all reinforced concrete and structural steel structures.

(c) Any other data, drawings and information required to be submitted as per various clauses of the specification.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable

2.6.0 BUS BARS AND BUS BAR SUPPORTS

2.6.1.1 The bus bars shall be outdoor strung bus bars with ACSR conductor supported on lattic.

2.6.1.2 If asked for, the substation steel structures shall be designed as per ***Section-3*** of this specification.

2.7.0 ACSR CONDUCTORS

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

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

Sl. No.	DESCRIPTION	ACSR 'MOOSE'	ACSR 'ZEBRA'	ACSR 'PANTHER'
1	Code name	MOOSE	ZEBRA	PANTHER
2	Number of strands & size	Al: 54/ 3.53 mm St: 7/ 3.53 mm	Al: 54/ 3.18 mm St: 7/ 3.18 mm	Al: 30/ 3.00 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	$23x10^{-6}$ / ºC	$19.35x10^{-6}$ / ºC	$19.35x10^{-6}$ / ºC
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 20º 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

2.8.0 ELECTRICAL CLEARANCES

2.8.1 Following minimum electrical clearances (outdoor) shall be maintained in the switchyard:

Sl. No.	Clearance	220 KV	132 KV	33 KV
1	Phase to Phase	2400 mm	1300 mm	320 mm
2	Phase to Earth	2400 mm	1300 mm	320 mm
3	Sectional Clearance	5000 mm	4000 mm	2800 mm
4	Live part to ground	5500 mm	4600 mm	3700 mm
5	Base of insulator (supporting live part) to ground	2500 mm	2500 mm	2500 mm

2.9.0 EARTHING SYSTEM

2.9.1 General

(a) Earthing system shall be installed as per drawings provided with this bidding document.

(b) The main earthing system for the switch yard shall consist of a mesh made out of Galvanised MS flats of size not less than 65 mm in width and12 mm thick covering the entire switchyard area and earth electrodes distributed all over the mesh. The earth electrodes shall also be placed all around the periphery of the mesh at regular intervals.

(c) The earth mat shall be created by laying the earthing conductor (Galvanised MS flats) in both directions perpendicularly. The mesh points so created and all other joints shall be welded and painted and painted with rust proof paint after welding.

(d) Minimum depth of burial of main earthing conductors shall be 600 mm from FGL.

(e) Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.

(f) The earthing system must conform to requirements of the Indian Electricity Rules and the provisions of IS: 3043.

(g) All earth electrodes and risers for equipment and other earthing must be connected at mesh points of the earth mat. All such connections shall be welded.

(h) All metallic supporting structures and non-current carrying metallic parts of all equipment shall be provided with double earthing.

(i) All LAs, VTs, CVTs and all transformer neutrals must be earthed through separate earth electrodes and in turn these electrodes shall be connected to the main earth grid.

(j) One number 40mm dia, 3000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive &inductive voltage transformers, lightning masts and towers with peak.

(k) 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.

(l) The earthing system in the Control Room must also be connected to the main station grid. For this purpose, earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building which in turn shall be connected to the main earth grid by two runs of 65mm x 12mm GI flats.

(m) Each earthing lead from the neutral of the power transformers shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points. These electrodes must also be connected to the Main Earth Mat of the substation.

2.9.2 Summary of Earthing System

Sl. No.	Item	Size	Materials
1	Main Earthing Conductor to be buried in ground	65mm x 12 mm	GI Flat
2	Conductor above ground & earthing leads (for equipment)	65mm x 12 mm	GI Flat

3	Conductor above ground & earthing leads (for columns & aux. structures)	65mm x 12 mm	GI Flat
4	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc.	50mm x 6 mm	GI Flat
5	Rod Earth Electrode	40mm dia, 3000 mm long	Mild Steel
6	Pipe Earth Electrode (in treated earth pit) as per IS 3043	40mm dia, 3000 mm long	Galvanised Steel

2.10.0 PROTECTION AGAINST DIRECT LIGHTNING

2.10.1 Protection against direct lightning shall be provided by stringing GI shield wires and/or by lightning masts (SPIKES) as per layout drawings attached.

2.10.2 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

2.10.3 Down conductors shall be cleated on the structures at 2000 mm interval. For grounding of lightning spikes and shield wires, 7/3.66 mm GI steel wires shall be used.

2.10.4 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earth-mat.

2.10.5 Two runs of down conductors shall be used for grounding of each Lightning Spikes. For that, lugs with bolts shall be provided at base of spikes.

G.I. wires for shielding shall conforming to IS 2141.Parameters of galvanised steel wires shall be as follows:

a) No of Strand: 7
b) Diameter of single strand: 3.66 mm
c) Minimum Breaking Load: 6970 KG
d) Overall Diameter: 10.98 mm
e) Area: 72.25 mm2

2.11.0 BAY MARSHALLING KIOSK

2.11.1 **1 (One)** number of bay marshalling **kiosk** shall be **provided for each 220 kV bay** under present scope. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose: -

(i) Incoming:
To receive **2(two)** incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and

(ii) Outgoing:
(a) To distribute **4(four)** outgoing 415V, 16 Amps 3 phase AC supplies to be controlled by MCB.
(b) To distribute **3(three)** outgoing 240V, 16 Amps single phase supplies to be controlled by MCB.
(c) To distribute **3(three)** outgoing 240V, 10 Amps single phase supplies to be controlled by MCB

2.11.2 The steel sheet thickness of BMK shall be minimum 3.15 mm and painting shall be as per Clause 2.15.0.

2.11.3 **The BM shall be protective Class of IP 55.**

2.11.4 The BMK shall have a minimum of 700 mm clearance to switchyard floor.

2.12.0 INSULATOR AND HARDWARE FITTINGS

2.12.1 General

a) The Contractor shall supply insulators of suspension, tension and post type as required complete with all necessary hardware and accessories, including fittings for fixing insulators to steel structures as required.

b) The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

c) Unless otherwise specified, the glaze shall be brown colour. The glaze shall cover all the porcelain parts of the insulators except those areas which serve as support during firing or are left unglazed for purpose of assembly.

d) The design of the insulator shall be such that stress due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

e) Cement use in the construction of insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fitting and its thickness shall be as uniform as possible.

f) Pins and caps shall be made of drop forged steel, duly hot dip galvanized as per IS 2629.These shall not be made by jointing, welding, shrink fitting or any other process.

g) Security clips/split pins shall be made of good quality of stainlesssteel.

h) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tensionstrings.

i) Post type insulators shall be of long rod type or solid core type and preferably of single piece type for all voltage classes. These shall be complete with necessary fittings to hold Aluminium tubes or ACSR conductor as required.

j) The items of hardware and fittings shall make complete assemblies which are necessary for their satisfactory performance. Such parts shall be deemed to be within the scope of this specification.

2.12.2 Disc Insulator Strings

Each insulator string shall consist of following numbers of Disc & parameters.

Sl. No.	Description	No of Disc Insulator Unit for		
		220 kV	**132 kV**	**33 kV**
1	No. of Disc, Suspension String	14	9	3
2	No. of Disc, Tension String	15	10	4
3	Creepage Distance of complete String (min)	6125 mm	3625 mm	900 mm

2.12.3 Parameters

2.12.3.1 Disc Insulators

a) Type : Ball and Socket
b) Colour : Brown
c) Surface : Glazed
d) Locking Device : W or R type security clip
e) Size of Disc : 255 mm x 145 mm
f) Size of Pin Ball : 16 mm
g) Creepage Distance
(Min subjected requirement of clause 2.19.2):25 mm/kV
h) Electro mechanical Strength : 70 KN
i) Power frequency withstand test voltage : 75 KV Dry
j) Minimum dry Impulse withstand : 125 KV
peak Test voltage (+/- wave)
k) Puncture Voltage : 1.3 X actual dry flash over voltage.

2.12.3.2 Post Insulators

Sl. No.	Parameters	220 kV	132 kV	33 kV
1	Highest system voltage	245 kV	145 kV	36 kV
2	Dry one minute power frequency test voltage	510 kV	275 kV	75 kV
3	Wet one minute power frequency test voltage	460 kV	275 kV	75 kV
4	Impulse voltage withstand test	510 kV	650 kV	170 kV
5	Minimum Creepage Distance	31mm/kV	31mm/kV	31mm/kV
6	Minimum Bending Strength (upright)	6 kN	4 kN	3 kN

2.13.0 CLAMPS, CONNECTORS AND SPACERS

2.13.1 Clamps and connectors shall conform to IS 2121 unless otherwise mentioned hereunder.

2.13.2 Clamps and connectors shall be made of materials listed below: -

(i) For connecting ACSR: Aluminium alloy casting conforming to designation A6 of IS 617.
(ii) For connecting equipment: Bimetallic connectors made from aluminium alloy terminals made of copper casting conforming to designation A 6 of IS 617.
(iii) For connecting GI Shield wire: Malleable iron casting.
(iv) Expansion Connectors: Copper lamination to grade FRTP-2 of IS 191.
(v) Bolts, nuts, plain washers: Hot dip galvanised mild steel and spring washers for items (i), (ii) and (iii).

2.13.3 Spacers

Spacers shall conform to IS 10162. Spacers for bundle conductors (where specified) shall be provided at but not limited to the following locations:

(i) At intervals not exceeding 2.5 meters in case of strung bus bars or other bundled strung conductors.
(ii) At one meter interval in case of jumper connections.

No magnetic material shall be used in fabrication of spacers except for the GI bolts and nuts.

2.13.4 **T Clamp and Equipment Clamps**

a) T Clamps:

i. Standard Specification and tests shall be as per IS:5561.
ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.
iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.
v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.
vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.
vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.
viii. All sharp edges and corners shall be blurred and rounded off.
ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.
x. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

b) Equipment Clamps (CVT, CB, ISOLATOR, CT, etc.):

i. Standard Specification and tests shall be as per IS:5561.
ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.

iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.

v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.

vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.

vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.

viii. All sharp edges and corners shall be blurred and rounded off.

ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

2.14.0 ILLUMINATION SYSTEM

2.14.1 The Contractor shall design, supply and install illumination system for the entire substation.
The average illumination level and limiting glare index for different parts of the substation shall be as follows:

Sl. No.	Location/Area	Average Illumination Level, 'Lux'	Limiting Glare Index
1	Control Room	300	19
2	Battery Room	100	19
3	Carrier Room	300	
4	Office/Conference Room	300	
5	Stairs and Corridors	100	
6	Air Conditioning Plant	150	
7	Outdoor Switchyard	20	
8	Approach Road	20	
9	Store Room	100	

2.14.2 The lighting system of a particular area whether indoor or outdoor shall be designed such a way that uniform illumination level is achieved. In outdoor switchyard illumination shall be aimed as far as possible towards transformers, circuit breakers, isolators etc.

2.14.3 Following types of lamps shall be used for various location of the substation:

Sl.No.	Location/Area	Type of Lamp	Type of Fitting
1	Control Room, Office, Carrier Room	LED	Decorative
2	Battery Room	Fluorescent	Acid Proof, Industrial
3	Outdoor Switchyard	LED	Water Tight Flood Light
4	External Lighting on Buildings	LED	Water Tight Flood Light
5	Gate Lighting	LED	Post type, water tight Flood Light

2.14.4 Provisions shall be made in the switchyard steel structures for mounting of lamps for switchyard.

2.15.0 PAINITNG

2.15.1 All surfaces of ferrous materials used for construction of outdoor equipment and enclosures such as instrument transformer main tanks and equipment, marshalling boxes, kiosk, operating boxes, metallic enclosures etc. shall be cleaned and painted as given below if not specified otherwise in respective Sections. The quality of paint such that its colour should not fade even if it is exposed to temperature up to 1200-degree C.

Description	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	DFT	Colour Shade
CT & PT Main tanks of CT, PT and other oil filled equipment, etc. (**External surface)**	Shot Blast cleaning Sa 2½ (ISO 8501-1)	Epoxy base zinc primer (30-40 mm)	Epoxy high build micaceous iron oxide (75 mm)	Aliphatic Polyurethane 2 coats (25 mm/coat)	Minimum 155 mm	Shade No. 631 of IS:5
do (**Internal surfaces)**	Shot Blast cleaning Sa 2½ (ISO 8501-1)	Hot oil resistant, non-corrosive varnish or paint or epoxy			Minimum 30 mm	Glossy white or paint
Marshalling boxes, operating	Chemical/Shot Blast cleaning Sa	Epoxy base zinc primer (30-40 mm)				

2.15.2 All paints shall be carefully selected to withstand heat, rain and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

2.15.3 In case finish paint chips off or crinkle during transit or installation, the contractor shall arrange for repainting transformer at site at his cost. The paint for repainting/touchup shall be supplied by the contractor.

2.15.4 The paint work done shall be guaranteed for a minimum period of 5 years from the date of receipt of the equipment.

2.15.5 1(One) coat of additional paint to the exposed exterior surfaces shall be given at site prior to commissioning in presence of the Employer's representative.

2.16.0 SUPPLY OF CONSTRCUTION MATERIALS BY THE CONTRACTOR

2.16.1 The contractor has to make his own arrangements for procurement, supply and use of construction materials like cement, M.S. rounds, H.B.G. metal and sand.

2.16.2 Cement

The contractor has to make his own arrangements for the procurement of cement to required specifications required for the work subjected to the follows:

a) The contractor shall procure cement (approved BSI marked of PPC of Grade 53), required for the works only from reputed cement factories (Main producer) acceptable to the Engineer-in-Charge. The contractor shall be required to be furnished to the Engineer in-Charge bills of payment and test certificates issued by the manufacturers to authenticate procurement of quality cement from the approved cement factory.
The contractor shall make his own arrangement for adequate storage of cement.

b) The contractor shall procure cement in standard packing of all 50 kg per bag from the authorized manufacturers. The contractor shall make necessary arrangement at his own cost to the satisfaction of Engineer-in-Charge for actual weighment of random sample from the available stock and shall conform with the specification laid down by the Indian Standard Institution or other standard foreign institutions laid down by the Indian Standard Institution or other standard foreign institutions as the case may be. Cement shall be got tested for all the tests as directed by Engineer-in-Charge at least one monthin
advance before the use of cement bags brought and kept on site Stores. Cement bags required for testing shall be supplied by the contractor free of cost. If the tests prove unsatisfactory, then the charges for cement will be borne by the Contractor.

c) The Contractor should store the cement of 60 days requirement at least one month in advance to ensure the quality of cement so brought to site and shall not remove the same without the written permission of the Engineer-in-Charge. The Contractor shall forthwith remove from the works area any cement that the Engineer-in-Charge may disallow for use, an account of failure to meet with required quality and standard.

d) The contractor shall further, at all times satisfy the Engineer-in-Charge on demand, by production of records and books or by submission of returns and other proofs as directed, that the cement is being used as tested and approved by Engineer-in-Charge for the purpose and the Contractor shall at all times, keep his records up to date to enable the Engineer-in-Charge to apply such checks as he may desire.

e) Cement which has been unduly long in storage with the contractor or alternatively has deteriorated due to inadequate storage and thus become unfit for use in the works will be rejected by the department and no claim will be entertained. The Contractor shall forthwith remove from the work area, any cement the Engineer-in-Charge may disallow for use on work and replace it by cement complying with the relevant Indian Standards.

2.16.3 Steel

The Contractor shall procure mild steel reinforcement bars, high yield strength deformed (HYSD) bars, rods and structural steel, etc., required for the works, only from the main or secondary 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.

2.17.0 SUPPLY OF CONSTRCUTION MATERIALS BY THE EMPLOYER

2.17.1 As it is a single responsibility contract supply, and/or arrange all materials and services including construction and testing equipment to complete the works in all respects described in the specification, shall be under the scope of the Contractor unless otherwise specifically mentioned elsewhere in the bidding document.

2.18.0 MISCELLANEOUS GENERAL REQUIREMENTS

2.18.1 Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

2.18.2 All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

2.18.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

2.18.4 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10conforming to IS:456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

2.18.5 Bricks having minimum 75 kg/cm2 compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75kg/cm2 compressive strength before submitting his offer.

2.18.6 Angles 50 x 50 x 6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/ openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole pre-cast cover and any other place where breakage of corners of concrete is expected.

2.18.7 Anti- termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.

2.18.8 Items/components of equipment/materials/components etc. not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

SECTION-3
SPECIFICATION FOR DESIGN AND FABRICATIONOF SUBSTATION STEEL STRUCTURES

3.10 SCOPE

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

3.2.0 MATERIALS

3.2.1 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.

3.2.2 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

3.2.3 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.

3.2.4 Washers

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

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

3.2.5 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.

3.2.6 Other Materials

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

3.3.0 DESIGN PARAMETERS

3.3.1 Switchyard structures such as columns, beams and equipment mounting structures shall be designed as per drawing provided along with this bidding document.

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

3.3.2 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.

3.3.3 Deviation Angle

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

3.3.4 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	0.05552ohm/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.

3.4.0 DESIGN DRAWINGS

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

3.4.2 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 CONTRACTOR only and the CONTRACTOR shall ensure that all the members can be fitted while erecting without any undue strain on them.

3.5.0 ACCESSORIES

3.5.1 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.

3.5.2 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 CONTRACTOR.

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 CONTRACTOR.

3.5.3 Earth wire Clamps Attachment

i. **Suspension Clamp**

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

ii. **Tension Clamps**

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

3.6.0 FABRICATION

3.6.1 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

3.6.2 Drilling and Punching

3.6.2.1 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.

3.6.2.2 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 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.

3.6.2.3 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.

3.6.3 Erection mark

3.6.3.1 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.

3.7.0 GALVANIZING AND PAINTING

3.7.1 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 IIS: 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.

3.7.2 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.

3.7.3 The outside surface shall be galvanised. Sample of galvanised materials shall be supplied to the galvanised test set out in IIS 729 or other such authoritative international standards.

3.8.0 EARTHING

3.8.1 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 GII 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.

3.9.0 TEST AND TEST CERTFICATE

3.9.1 Each consignment ready for transportation shall be offered to ASEB 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.

3.10.0 TEST AT CONTRACTOR'S PREMISES

3.10.1 The CONTRACTOR 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.

3.10.1.1 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 members 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.

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

SECTION-4
TECHNICAL SPECIFICATION OF OUTDOOR SF6 CIRCUIT BREAKERS

4.1.0 SCOPE

4.1.1 The intention of this Section of the Specification is to cover design, manufacture, testing at manufacturer's works of Circuit Breakers with all fittings and accessories including mounting structures as applicable

4.1.2 Loading at manufacturer's works, transportation and delivery at respective substation sites, including unloading at destination sites.

4.1.3 Erection, Testing and Commissioning of Circuit Breakers.

4.2.0 GENERAL REQUIREMENTS

4.2.1 The circuit breaker shall be of three phase unit (gang operated) (or) three identical single phase units (as said in data sheet), outdoor, single pressure puffer type. The operating mechanism shall be electrically and mechanically trip/free with anti-pumping facility suitable for remote electrical closing, tripping as well as local Operation facility as specified. The CBs are meant for installation with Transformers LV side & bus section.

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

4.2.3 The circuit breaker shall be capable of switching transformer-magnetizing currents and shall be restrike - free.

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

4.2.5 All cable ferrules, lugs, tags, etc. required for cabling from equipment control cabinet/operating mechanism to the central control cabinet of the breaker shall be supplied loose as per approved schematics.

4.2.6 The SF6 breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics.

4.2.6.1 The support structure of circuit breaker shall be hot dip galvanised. Sufficient galvanising thickness shall be achieved with 615 gm/m². All other parts shall be painted as per painting specification enclosed separately.

4.3.0 OPERATING MECHANISM

4.3.1 A power spring operated mechanism for closing and tripping shall be provided in the breaker control cabinet. This device shall be so interlocked that while it is under maintenance, the breaker cannot be operated from remote. A slow acting, manually operated device shall be provided for inspection and maintenance purposes.

4.3.2 Circuit breaker operating mechanism shall be capable of storing energy for atleast two complete closing and tripping operations.

4.3.3 Each mechanism shall have an operation counter.

4.3.4 The operating mechanism shall be mounted and enclosed in a weather proof, vermin-proof, sheet steel cabinet conforming to IP: 55 degree of protection. Sheet steel thickness shall be as specified in data sheet. The cabinet shall also house relays, control and auxiliary equipment of each breaker and provision for terminating all control, alarm and auxiliary circuits. It shall be provided with hinged doors with provision for locking and removable gland plates to be drilled at site. Inspection window shall be provided for observation of the instruments without opening the cabinet. It shall be mounted so as to provide convenient access from ground level.

4.3.5 The cabinet shall be fitted with a thermostatically controlled anti-condensation heater, a 15A, 1 phase, 5 pin socket outlet with switch and a cubicle illuminating lamp suitable for operation on 240 V AC 50Hz supply.

4.3.6 Circuit breakers shall feature high repeatability of absolute closing time over a wide range of parameters (ambient temperature, pneumatic pressure, control voltages, etc).

4.3.7 Main poles shall operate simultaneously. There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong, rigid, positive and fast in operation.

4.3.8 Disagreement circuit shall be provided which shall detect pole position discrepancy.

4.3.9 The design of the circuit breaker shall be such that contacts will not close automatically upon loss of gas/ air pressure.

4.3.10 Closing release shall be capable of operating within the range of the rated voltage as specified in the data sheet. Shunt trip shall operate satisfactorily under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker within the range of the rated voltages specified in the Data sheet.

4.3.11 Working parts of the mechanism shall be of corrosion resisting material. Bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

4.3.12 All controls, gauges, relays, valves, hard drawn copper piping and all other accessories as necessary shall be provided including the following:

4.3.12.1 Low pressure alarm and lock out relay with adjustable pressure setting suitable for operation on DC system.

4.3.12.2 A no-volt relay for remote indication of power failure for compressor motor/ Spring Charge motor.

4.3.13 As long as power is available to the motor, continuous sequence of closing and opening operations shall be possible.

4.3.14 After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible.

4.3.15 Motor rating shall be such that it requires only about 30 seconds for full charging of the closing spring.

4.3.16 Closing action of the circuit breaker shall compress the opening spring ready for tripping.

4.3.17 During closing, springs are discharged and after closing of breaker, springs shall automatically be charged for the next operation. Facility for manual charging of closing springs shall be provided. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

4.4.0 OPERATING MECHANISM CONTROL

4.4.1 The breaker shall normally be operated by remote electrical control. Two electrically independent trip circuit including two trip coils per pole shall be provided. However, provision shall be made for local electrical control. For this purpose, a local/remote selector switch, close and trip control switch/push button shall be provided in the breaker central control cabinet.

4.4.2 The two way Local/Remote switch shall have minimum 4 (four) pair of contacts and wiring shall be made

available to monitor local/remote status from local SCADA/SAS.

4.4.3 The trip coils shall be suitable for trip circuit supervision during both open and close position of the breaker. Necessary terminals shall be provided in the central control cabinet of the circuit breaker by the CONTRACTOR.

4.4.4 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

4.4.5 A conveniently located manual tripping lever or button shall also be provided for local tripping of the breaker and simultaneously opening the reclosing circuit. A local manual closing device which can be easily operated by one man standing on the ground shall also be provided for maintenance purpose. Direction of motion of handle shall be clearly marked.

4.4.6 Necessary platform with Ladder shall be provided for easy access to the Operating Box thereby easing out local operation/maintenance.

4.4.7 **When the spring get fully charged either through motor or hand cranking, the spring charging motor and the hand cranking device should get disengaged mechanically from the charged spring and this should not be depended upon only the limit switch**.

4.5.0 SF6 GAS SYSTEM

4.5.1 SF6 gas shall serve as an arc-quenching medium during opening/closing operation and as an insulating medium between open contacts of the circuit breaker.

4.5.2 The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.

4.5.3 All gasketed surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 1% per year.

4.5.4 In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as fully compatible with Sf_6 gas decomposition products.

4.5.5 Each pole shall form an enclosure filled with Sf_6 gas independent of two other poles (for 245 & **145 kV CBs**) and the Sf_6 density of each pole shall be monitored.
For CBs of voltage class of 36kV, a common Sf_6 scheme/density monitor shall be acceptable.

4.5.6 The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale and shall meet the following requirements:
It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.

4.6.0 BUSHINGS AND INSULATORS

4.6.1 Bushings and Insulators shall be of Porcelain, Solid core type.

4.6.2 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC- 60137, while Hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS: 5621.
The support insulators shall be manufactured and tested as per IS: 2544/IEC-60168 and IEC-60273.
The insulators shall also conform to IEC-60815 as applicable

4.6.3 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.

4.6.4 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.

4.6.5 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.

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

4.7.0 FIXED AND MOVING CONTACTS

4.7.1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be adjustable to allow for wear, easily replaceable and shall have minimum moving parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear out.

4.7.2 Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced.

4.7.3 If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.

4.8.0 INTERLOCKS

4.8.1 Key release mechanical interlocks shall be incorporated in the operating mechanism for interlocking with the associated isolators, so that operation of the circuit breaker is dependent on a "key-trapped" situation. In addition, electrical interlocks with associated isolators shall be provided.

4.9.0 ADDITIONAL DUTY REQUIREMENTS

4.9.1 Circuit breakers shall be capable of clearing short line faults with the same impedance behind the bus corresponding to the rated fault current.

4.9.2 Circuit breakers shall be capable of breaking 25% of rated fault current at twice rated voltage under out of phase conditions.

4.9.3 The Bid shall highlight the design features provided to effectively deal with:

a) Breaking of inductive currents and capacitive currents.
b) Charging of long lines and cables.
c) Clearing developing faults within the full rating of the breaker.
d) Opening on phase opposition.

4.10.0 ACCESSORIES

4.10.1 Gas Pressure Detector

The circuit breaker shall be provided with gas pressure monitor with temperature compensation for initiating alarm and locking the operating mechanism in the event of abnormality.
Gas pressure monitor shall be provided for each pole individually.

4.10.2 Position Indicator

Each pole of the circuit breaker shall be provided with a position indicator.

4.10.3 Terminals

Each circuit breaker shall be provided with suitable terminal pads of high conductivity aluminium alloy

for connecting to the line.

4.10.4 Auxiliary Switches

Each circuit breaker shall be equipped with auxiliary switches with sufficient number of contacts for control, indication and interlocking purposes. Ten normally open and ten normally closed contacts shall be provided as spares. All contacts shall be rated for the DC voltage specified in data sheet.

4.10.5 Terminal Blocks

All accessories and control devices shall be completely wired. All wirings which are connected to external circuit shall be terminated on terminal blocks installed in the control cabinet. The terminal blocks provided shall have twenty (20) percent spare terminals.

4.10.6 Operating mechanism housing shall be supplied with all required accessories including the following:

a) Padlocks and duplicate keys.
b) Space heaters equipped with automatic thermostatic control.
c) Local/remote changeover switch.
d) Manually operated tripping push button/lever (mechanical) conveniently located to trip all three phases simultaneously.
e) Control switches to cut off control power supplies.
f) Fuses as required.
g) Two earthing terminals.
h) Auxiliary relays required for satisfactory operation.
i) Motor contactor with thermal release
j) Provision for mechanical interlock with isolator.
k) Readable wiring diagram shall be pasted inside the front cover of the operating mechanism box with indelible ink.

4.11.0 SUPPORT STRUCTURES

4.11.1 The Circuit Breakers shall be suitable for mounting on steel structures.

4.11.2 The support structure shall be of steel hot dip galvanised type. The height of support structure shall be designed to keep the bottom most live part and bottom of insulators of circuit breakers at minimum clearance from the plinth as specified in data sheet.

4.11.3 All necessary galvanised bolts, nuts and washers to complete the erection shall be furnished including the embedded anchor bolts for securing the supporting structure to the concrete foundations.

4.12.0 NAME PLATES

4.12.1 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.

4.13.0 EARTHING

4.13.1 Two earthing pads shall be provided on each supporting structure. Each control cabinet or terminal box mounted on the supporting structure shall also be connected to an earthing pad. Separately mounted control cabinets shall be provided with two earthing pads adjacent to the base of the cabinet. The earthing connection shall be bolted type and suitable for receiving 65mm x 12mm MS strip.

4.14.0 TERMINAL CONNECTORS

4.14.1 The equipment shall be supplied with required number of terminal connectors of approved type suitable for ACSR conductors. 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.

4.15.0 TESTS

4.15.1 All routine tests shall be carried out in accordance with relevant IS.

All routine/acceptance tests shall be witnessed by the Purchaser/his authorised representative. The tests shall include the following:

a) Routine/Acceptance Tests (all units)

i) Mechanical Operation tests
ii) Power frequency voltage withstand test (dry)
iii) Tests on auxiliary & control circuits
iv) Measurement of resistance of the main circuit.

b) Type Tests:

The bidder shall furnish type test certificates and results for the following tests along with the bid for breaker of identical design.

i) Breaking and making capacity test
ii) Short-time current test
iii) Temperature rise tests
iv) Lightning Impulse voltage test

c) Special Tests:

The operating mechanism box shall be tested for paint film thickness and the galvanisation test for structure shall be conducted in one of the unit of each type.

d) Test Certificates

Copies of routine/acceptance test certificates shall be produced with the endorsement of the inspecting authority to the Purchaser before effecting dispatch. The test report shall contain the following information.

i) Complete identification data, including serial No. of the breaker.
ii) Method of application, where applied, duration and interpretation of results in each test.

4.16.0 PRE-COMMISSIOING TESTS

(a) Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Insulation resistance of each pole.
(b) Check adjustments, if any suggested by manufacturer.
(c) Breaker closing and opening time.
(d) Slow and Power closing operation and opening.
(e) Trip free and anti-pumping operation.
(f) Minimum pick-up voltage of coils.
(g) Dynamic Contact resistance measurement.
(h) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
(i) Insulation resistance of control circuits, motor etc.
(j) Resistance of closing and tripping coils.
(k) SF6 gas leakage check.
(l) Dew Point Measurement
(m) Verification of pressure switches and gas density monitor.
(n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
(o) Testing of grading capacitor.
(p) Resistance measurement of main circuit.
(q) Checking of operating mechanism.
(r) Check for annunciations in control room

4.17.0 SPECIAL TOOLS AND TACKLES

4.17.1 The Bidder shall furnish a list of any special tools and tackles required for maintenance and operation purposes with recommended quantities for each substation.

4.17.2 TECHNICAL DATA SHEET FOR CIRCUIT BREAKER

	Particulars	Unit	Data for 132 kV CB	Data for 33 kV CB
1	Type		Sf_6	Sf_6
2	No of poles		3 (3 Phase Ganged Unit)	3 (3 Phase Ganged Unit)
3	Service		Outdoor	Outdoor
4	Rated System Voltage	kV	132	33
5	Highest System Voltage	kV	145	36
6	System earthing		Solidly earthed system	Solidly earthed system
7	Rated Voltage of Breaker	kV	145	36
8	Rated Continuous Current	Amps	1250	1250
9	Rated Frequency	Hz	50	50
10	Rated Short Circuit breaking current (I) – 3 sec - symmetrical	kA	31.5	25
11	Rated Short Circuit making current	kA	2.5*I	2.5*I
12	Duty cycle		0-0.3 Sec-CO-3Min –CO	0.3Sec-CO-3Min–CO
13	First pole to clear factor		1.3	1.3
14	Operating time			
	i) Opening Time	ms	Not exceeding50ms	Not exceeding 50ms
	ii) Closing Time	ms	Not exceeding120ms	Not exceeding 120ms
15	Insulation level			
	i) Power Frequency with Stand Voltage	kV	275	70
	ii) Impulse withstand Voltage	kV	650	170
16	Minimum clearance between phases	m	1300	320
17	Minimum clearance between phase to earth	mm	1300	320
18	Minimum Ground clearance (from bottommost live part to plinth level)	mm	4600	4000
19	Minimum clearance from bottom Of Support insulator to plinth level	mm	2500	2500
20	i) Minimum Creepage Distance (Total)	mm	3635	900
	ii) Minimum Creepage Distance (Protected)	mm	1813	460
21	Arcing horn			Yes
22	Operating mechanism:			
	a) Type		Spring Charged	Spring Charged
	b) Rating of Drive Motor	V	Universal Motor/ 1 Phase 50 Hz 230V AC	Universal Motor/ 1 Phase 50 Hz 230V AC

	c) Rated voltage of Shunt trip coil & operating range	V. DC	220 or 110 [50% - 110%]	220 or 110 [50% - 110%]
	(d) Rated voltage of Closing coil & operating range	V. DC	220 or 132 [80% - 110%]	220 or 132 [80% - 110%]
	(e) No. of trip coils	No	2 per CB	2 per CB
	(f) No. of closing coils	No	1 per CB	2 per CB
	g) No of spare auxiliary contacts & contact rating	Nos. AMPS	10 N/O+10 N/C (per CB) 10A at 240V AC & 2A at 220V/110V DC	10 N/O+10 N/C (per CB) 10A at 240V AC & 2A at 220V/110V DC
	h) Minimum thickness of sheet steel for control cabinet	mm	3	3
	i) Enclosure Protection		IP55	IP55
23	Reclosing		Three Phase Auto Reclosing	Three Phase Auto Reclosing
24	Support structure (Painted / Galvanised)		Galvanised	Galvanised
25	All other parts (Painted / Galvanised)		Synthetic enamel shade 631 of IS5(125 microns)	Synthetic enamel shade 631 of IS5(125 microns)
26	Minimum size of control wiring (Copper)	Sq.mm	2.5	2.5

SECTION-5
TECHNICAL SPECIFICATION OF OUTDOORCURRENT AND POTENTIAL TRANSFORMERS

5.1.0 SCOPE

5.1.1 This Section of the Specification covers general requirements for design, engineering, manufacture, assembly and testing at manufacturer's works of Live Tank type outdoor Current and Potential Transformers, also referred to as Instrument transformers.

5.1.2 Loading at manufacturer's works, transportation and delivery at respective substation site including unloading at destination site.

5.1.3 Erection, Testing and Commissioning of Instrument Transformers.

5.2.0 STANDARDS

5.2.1 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 or equivalent IEC and shall conform to the regulations of local statutory authorities.

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

5.2.3 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
(v) Purpose application.
(v) IS: 3156(Part-I) Potential transformers: General requirement.
(vi) IS: 3156 (Part-II) Potential transformers: Measuring Potentialtransformers
(vii) IS: 3156 (Part-III) Potential transformers: Protective Potential transformers

5.3.0 GENERAL REQUIREMENTS

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

5.3.2 Instrument transformers shall be of **Live Tank design.**

5.3.3 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 is requested to quote the current transformers with stainless steel diaphragm (bellow).
All parts of bellow shall be stainless steel only. ***A ground glass window shall be provided to monitor the position of the metal bellow.***

5.3.4 The instrument transformers shall be completely filled with oil.

5.3.5 A complete leak proof secondary terminal arrangement shall be provided with each instrument transformers. All secondary terminals shall be brought out 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.

5.3.6 All instrument transformers shall be of single-phase unit.

5.3.7 All Instrument transformers shall be suitable for upright mounting on latticed steel structures.

5.3.8 The Instrument Transformer shall be complete in all respects and shall conform to the modern practice of design and manufacture.

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

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

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

5.3.12 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.

5.3.13 All steel work shall be degreased, pickled and phosphate and then painted in accordance with Clause 2.15.0 (Painting)

5.3.14 The outer surface of metal tank shall be Hot Dip Galvanized, whereas, the inner portion shall be painted in accordance with Clause 2.15.0(Painting) or hot dip galvanised.

5.3.15 The galvanising shall be as per applicable standard IS: 2629 and minimum thickness of zinc coating shall be 610 gm/sq.mt.

5.4.0 INSULATING OIL

5.4.1 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 / IEC 60296 (required for first filling)

5.5.0 COMMON MARSHALLING BOXES

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

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

5.5.3 1(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.

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

5.5.5 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.

5.5.6 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.

5.5.7 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.

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

5.5.9 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.

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

5.5.11 All steel works of common marshalling boxes shall be hot dipped galvanized.

5.5.12 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)

5.6.0 BUSHINGS AND INSULATORS

5.6.1 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.

5.6.2 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.

5.6.3 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.

5.6.4 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.

5.6.5 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.

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

5.7.0 TESTS

5.7.1 Routine/Acceptance Tests (all units)

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

5.7.1.2 In addition, following tests on Current Transformers shall also be carried out as Routine Tests:
I) Measurement of Capacitance.
II) Oil leakage test.
III) Measurement of tan delta at 0.3, 0.7, 1.0 Um/√3 and 10 kV

5.7.1.3 At factory/works tests the Ten Delta shall not exceed 0.3% (at Um/√3). The same shall not exceed 0.7% at the end of warranty period (refer SCC clause 5.10.0 of Vol-1). If tan delta value of CTs exceed prescribed limit of 0.7% within warranty period, it will be considered as failure within warranty period (Tan delta & capacitance test of CTs shall be measured at 10KV at site). The bidder has to replenish failed CTs within guarantee period without any cost implication to AEGCL.

5.7.2 Type Tests

5.7.2.1 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.

5.8.0 NAME PLATES

5.8.1 All equipment shall have non-corrosive name plates conforming to requirements of IS and fix at a suitable position and indelibly marked with full particular there on in accordance with the standard adapted.
The rated current, extended current rating (if specified) along with year of manufacture must be clearly indicated on the name plate.
The rated thermal current in case of CT shall also be marked on the name plate.

5.9.0 MOUNTING STRUCTURES

5.9.1 All the equipment covered under this specification shall be suitable for mounting on steel structures. Supply of mounting structures is also in the scope of this tender.

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

5.10.0 SAFETY EARTHING

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

5.11.0 TERMINAL CONNECTORS

5.11.1 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.

5.12.0 PRE-COMMSIONING TESTS

5.12.1 Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval:

(a) Current Transformers

i) Insulation Resistance Test for primary and secondary.
ii) Polarity test
iii) Ratio identification test - checking of all ratios on all cores by primary injection of current.
iv) Dielectric test of oil (wherever applicable).
v) Magnetising characteristics test.
vi) Tan delta and capacitance measurement.
vii) Secondary winding resistance measurement
viii) Contact resistance measurement (wherever possible/accessible)

(b) Voltage Transformers

i) Insulation Resistance Test for primary (if applicable) and secondary.
ii) Polarity test.
iii) Ratio test.
iv) Dielectric test of oil (wherever applicable).
v) Tan delta and capacitance measurement of individual capacitance stacks.
vi) Secondary winding resistance measurement

5.13.0 TECHNICAL DATA SHEET FOR CURRENT AND POTENTIALTRANSFORMERS

5.13.1 For 220,132 & 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 upto the terminal blocks.

5.13.2 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	**220kV**	**132kV**	**33 kV**
(B) Highest system voltage, kV	245	145	36
(C) Rated frequency, HZ	50	50	50
(D) System earthing	Solidly Earthed	Solidly earth	Solidly earth
(E) Insulation level			
(a) Impulse withstand voltage: kVp	1050	550	170
(b) One-minute p.f. Withstand voltage, kV (r.m.s.)	460	230	70
(F) Short time current for one second, kA	40	31.5	25
(G) Minimum creepage distance, mm	6125	3625	1800
(a) Tan Delta (for CTs only) at Um/√3, (Max)	0.3%	0.3%	0.3%
(H) Temperature rise	As per ISS		
(I) Feeder/ BYPASS/ Bus Coupler CT			
(i) No. of Cores	5	4	3
(ii) Transformation Ratio	As per schedule of requirement		
(iii)Rated Output			
(a) Core-1	30 VA	30 VA	30 VA

(b) Core-2	-	15 VA	15 VA
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(iv) Accuracy Class			
(a) Core-1	0.2	0.2	**0.2**
(b) Core-2	5P	5P	5P
(c) Core-3	PS	PX	PS
(d) Core-4	PS	PX	N.A
(e) Core-5	PS	N.A	N.A
(v) Accuracy Limit Factor			
(a) Core-1	-	--	-
(b) Core-2	-	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vi) Instrument security factor			
(a) Core-1	<5		
(b) Core-2	--	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vii) Minimum Knee point voltage, Volts			
(a) Core-1	-	-	-
(b) Core-2	1600	-	-
(c) Core-3	1600	1200	1200
(d) Core-4	800	1200	N.A
(e) Core-5	800	N.A	N.A
(viii) Maximum secondary resistance, ohm			
(a) Core-1	-	-	-
(b) Core-2	3	-	-
(c) Core-3	3	3	3
(d) Core-4	3	3	N.A
(e) Core-5	3	N.A	N.A
(ix) Maximum exciting current, at Vk/4 mA			
(a) Core-1	-	-	-
(b) Core-2	20	-	-
(c) Core-3	20	20	20
(d) Core-4	20	20	N.A
(e) Core-5	20	N.A	N.A
(J) Transformer CT			
(i) No. of Cores	5	4	3
(ii) Transformation Ratio	As per schedule of requirement		
(iii)Rated Output			
(a) Core-1	30 VA	30 VA	30 VA
(b) Core-2	-	15 VA	15 VA
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A

(e) Core-5	-	N.A	N.A
(iv) Accuracy Class			
(a) Core-1	**0.2**	0.2	**0.2**
(b) Core-2	PS	5P	5P
(c) Core-3	PS	PS	PS
(d) Core-4	PS	PS	N.A
(e) Core-5	PS	N.A	N.A
(v) Accuracy Limit Factor			
(a) Core-1	-	--	-
(b) Core-2	-	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vi) Instrument security factor			
(a) Core-1	-	-	-
(b) Core-2	10	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vii) Minimum Knee point voltage, Volts			
(a) Core-1	-	-	-
(b) Core-2	-	-	-
(c) Core-3	1600	1200	1200
(d) Core-4	800	800	N.A
(e) Core-5	N.A	N.A	N.A
(viii) Maximum secondary resistance, ohm			
(a) Core-1	-	-	-
(b) Core-2	-	-	-
(c) Core-3	30	30	30
(d) Core-4	20	20	N.A
(e) Core-5	20	N.A	N.A
(ix) Maximum exciting current, at Vk/4 mA			
(a) Core-1	-	-	-
(b) Core-2	3	-	-
(c) Core-3 (at Vk/4)	3	3	3
(d) Core-4	3	3	N.A
(e) Core-5	3	N.A	N.A
POTENTIAL TRANSFORMER			
(i) No. of secondary windings	3	2	2
(ii) Transformation ratio			
(a) Winding I	(220 kV/√3) / (110 V/√3)	(132kV/√3) / (110V/√3)	33kV/√3
(b) Winding II			/ 110V/√3
(c) Winding III		-	

(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:

(i) It is intended to use different ratios of the same CT at the same time for various protections and metering cores.

(ii) The CTS should therefore be suitable for the above purpose by secondary tapings only.

(iii) The ratio change by secondary taps is acceptable as long as the required CT specifications are achieved at all ratios.

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

SECTION-6
TECHNICAL SPECIFICATION OF ISOLATORS

6.1.0 SCOPE

6.1.1 This section of the specification is intended to cover design specifications for design, manufacture, testing at manufacturer's works of **gang operated Isolators** with all fittings and accessories, including mounting structures as applicable.

6.1.2 Loading at manufacturer's works, transportation and delivery at respective substation site, including unloading at destination site.

6.1.3 Erection, Testing and Commissioning of Isolators.

6.2.0 STANDARD

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

6.3.0 GENERAL

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

6.3.2 Isolators shall be outdoor, off-load type. Earth switches shall be provided on the isolators as and where specified with possibility of being mounted on any side of the isolator.

6.3.3 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.

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

6.3.5 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.

6.4.0 DUTY REQUIREMENTS

6.4.1 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.

6.4.2 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.

6.4.3 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.

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

6.4.5 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.

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

6.5.0 CONSTRUCTIONAL DETAILS

6.5.1 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.

6.5.2 Contacts:

6.5.2.1 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.

6.5.2.2 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.

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

6.5.2.4 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.

6.5.3 Blades:

6.5.3.1 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.

6.5.3.2 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.

6.5.3.3 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.

6.5.3.4 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.

6.5.4 Insulators:

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

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

6.5.5 Base:

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

6.6.0 EARTHING SWITCHES

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

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

6.6.3 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.

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

6.6.5 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.

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

6.6.7 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.

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

6.7.0 OPERATING MECHANISM

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

6.7.2 Control cabinet/operating mechanism box shall be made of aluminium sheet of adequate thickness (minimum3 mm).

6.7.3 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.

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

6.7.5 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.

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

6.7.7 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.

6.8.0 OPERATION

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

6.8.2 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 inter-pole 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.

6.8.3 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.

6.8.4 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 torsional 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.

6.8.5 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.

6.8.6 Signaling 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. Signaling 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.

6.8.7 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.

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

(i) Current transfer arrangement from main blades of isolator along with millivolt 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.

6.9.0 TEST AND INSPECTION

6.9.1 The switches shall be subjected to the following type test in accordance to with IS: 9921.

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

6.9.2 The equipment shall be subjected to the following routine test.

(i) Power frequency voltage dry withstand test on Main circuit.
(ii) Voltage Tests on control and auxiliary circuit.
(iii) Measurement of resistance of the main circuit
(iv) Mechanical Operating test.

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

6.10.0 AUXILIARY SWITCHES

6.10.1 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

6.11.0 CONNECTORS

6.11.1.1 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.

6.12.0 MOUNTING STRUCTURES

6.12.1 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 bidder. The isolators should have requisite fixing details ready for mounting them on structures.

6.13.0 PRE-COMMISSIONING TESTS

6.13.1 Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Insulation resistance of each pole.
(b) Manual and electrical operation and interlocks.
(c) Insulation resistance of control circuits and motors.
(d) Ground connections.
(e) Contact resistance.
(f) Proper alignment so as to minimise to the extreme possible the vibration during operation.
(g) Measurement of operating Torque for isolator and Earth switch.
(h) Resistance of operating and interlocks coils.
(i) Functional check of the control schematic and electrical & mechanical interlocks.
(j) 50 operations test on isolator and earth switch

6.14.0 TECHNICAL DATA SHEET FOR ISOLATORS

Sl. No.	Technical Particulars	Isolators class		
		220kV	**132kV**	**33 kV**
1	Nominal system voltage, kV	220	132	33
2	Highest system voltage, kV	245	145	36
3	Rated frequency, Hz.	50	50	50
4.	Type of Isolator	Single Centre Break	Single Centre Break	Double Break, centre pole rotating
5	Rated continuous current, A	1250	1250	1250
6	Rated short time current, kA	40	31.5	25
7	Rated duration of short time current, (second)	1	1	1
8	Rated lightning impulse Withstand voltage, kV (peak)			
	i) To earth & between poles	1050	650	170
	ii) Across isolating distance	1200	750	195
9	Rated 1 minute power frequency withstand voltage, kV (rms)			
	i) To earth & between poles	460	275	70
	ii) Across isolating distance	530	460	80
10	Minimum Creepage distance of insulators, mm	6125	3625	31mm/kV 900
11	Temperature rise	As per relevant IEC 62271-102/ IS 9921 As per relevant IS		

SECTION-7
TECHNICAL SPECIFICATION FOR SURGE ARRESTORS

7.1.0 SCOPE

7.1.1 This Section covers the specifications for design, manufacture, testing at manufacturers works before dispatch, subsequent dispatch of 220 KV, 132kV and 33kV, 10 kA, Station class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with fittings & accessories such as surge monitor, terminal connectors etc.
. including mounting structures as applicable.

7.1.2 Loading at manufacturer's works, transportation and delivery at respective substation site including unloading at destination site.

7.1.3 Erection, Testing and Commissioning of Surge Arresters.

7.2.0 STANDARDS

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

7.3.0 GENERAL REQUIREMENT

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

7.3.2 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.

7.3.3 The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

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

7.3.5 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.

7.3.6 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.

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

7.3.8 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.

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

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

7.3.11 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.

7.4.0 ARRESTOR HOUSING

7.4.1 The arrestor housing shall be made up of **polymer** for 220kV and **132kV systems** and porcelain/*polymeric for 66kV & 33kV systems* 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.

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

7.4.3 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.

7.4.4 Sealed housings shall exhibit no measurable leakage.

7.5.0 FITTINGS & ACCESSORIES

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

7.5.2 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 take-off.

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

7.6.0 SURGE MONITOR

7.6.1 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.

7.6.2 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.

7.6.3 The surge counter shall be provided with a potential free contact rated for 220/110 Volt (DC) which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to Substation Automation System.

7.7.0 TESTS

7.7.1 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:

i. Residual voltage test
ii. Reference voltage test
iii. Leakage current at M.C.O.V
iv. P.D. test
v. Sealing test
vi. Thermal stability test
vii. Aging and Energy capability test
viii. Watt loss test
ix. Each metal oxide block shall be tested for guaranteed specific energy capability in addition to routine/acceptance test as per IEC/IS.
x. The surge arrestor housing shall also be type tested and shall be subjected to

routine and acceptance tests in accordance with IS: 2071.

7.7.2 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.

7.8.0 NAME PLATE

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

(i) Rated Voltage
(ii) Continuous Operation Voltage
(iii) Normal discharge current
(iv) Pressure relief rated current
(v) Manufacturers Trade Mark
(vi) Name of Sub-station
(vii) Year of Manufacturer
(viii) Name of the manufacture
(ix) Purchase Order Number along with date

7.9.0 PRE-COMMISSIONING TESTS

7.9.1 Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment. Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Operation check of LA counters.
(b) Insulation resistance measurement.
(c) Capacitance and Tan delta measurement of individual stacks.
(d) Third harmonic resistive current measurement (to be conducted after Energisation.)

7.10.0 TECHNICAL DATA SHEET FOR SURGE ARRESTOR

Sl. No.	Particulars	Voltage class		
		220 k V	**132 kV**	**33 kV**
1	Rated voltage of arrester, kV	198	120	30
2	Rated frequency, Hz	50 Hz	50 Hz	50 Hz
3	Nominal discharge current of arrester, kA	10	10	10
4	Maximum residual voltage at nominal discharge current, kV (peak)	650	395	108
5	Maximum steep current impulse residual voltage at kV (kVP)	730	440	120
6	One minute power frequency withstand voltage ofarrester insulation, kV (rms)	460	275	70
7	1.2 / 50 second impulse withstand voltage of arrester insulation, kV (peak)	1050	650	170
8	Line discharge class	3	3	2
9	**Insulator Housing**			
	Power frequency withstand test voltage(wet) (kV rms)	460	275	70
	Lightning impulse withstand tests voltage (KVp)	1050	650	170
	Pressure Relief Class	40	40	40
	Creepage distance not less than (mm)	6125	3625	25 mm/kV

SECTION – 8
Technical Specification for Control and Relay Panels (With Automation)

8.1.0 SCOPE

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

8.1.2 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.

8.1.3 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.

8.2.0 STANDARDS

8.2.1 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.

8.3.0 TYPE OF PANEL

8.3.1 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.

8.3.2 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

8.4.0 CONSTRUCTIONAL FEATURES

8.4.1 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.

8.4.2 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.

8.4.3 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.

8.4.4 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.

8.4.5 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.

8.5.0 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.

8.6.0 INTERNAL WIRING

8.6.1 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.

8.6.2 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: 1.5 sq. mm. per lead.

(b) Instrument transformers circuit: 2.5 sq. mm. per lead.

8.6.3 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.

8.6.4 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.

8.6.5 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.

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

8.7.0 TERMINAL BLOCKS

8.7.1 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.

8.7.2 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.

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

8.7.4 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.

8.8.0 PAINTING

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

8.8.2 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.

8.8.3 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.

8.8.4 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.

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

8.8.6 The inside of the panels shall be glossy white.

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

8.9.0 NAME PLATES AND MARKINGS

8.9.1 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 each panel on front as well as rear side large and bold name plates shall be provided for circuit /feeder designation.

8.9.2 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.

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

8.10.0 MISCELLANEOUS ACCESSORIES

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

8.10.2 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)

8.10.3 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.

8.11.0 EARTHING

8.11.1 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.

8.11.2 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.

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

8.12.0 RECORDING METERS SAMAST (ABT COMPLIANT TRIVECTOR METERS)

8.12.1 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. Note: The secondaries of all the CT cores will be 1A.

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 (Range 110V 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°C.

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:

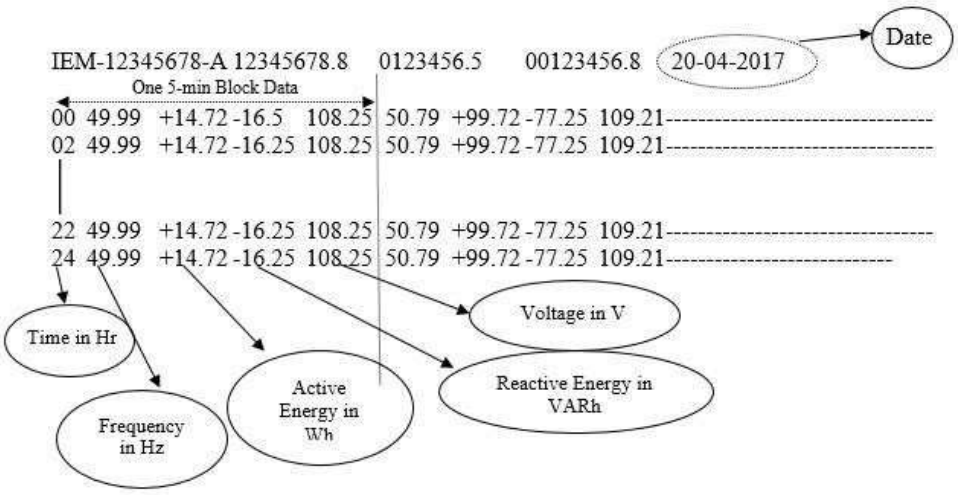

Figure 1: Standard Raw Data Format for IEM

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.

8.12.1 Constructional Features

a) 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.

b) 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.

c) 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.

d) 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.

8.12.2 Measurement

i. 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).

ii. 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.

iii. 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.

iv. 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.

v. 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.

vi. 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 33kV/110V, 132kV/110V, 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.

vii. 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.

viii. 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.

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

x. 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.

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

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

8.12.3 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.

8.12.4 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.

8.12.5 Communication

8.12.5.1 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 a 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.

8.12.5.2 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.

8.12.5.3 The Tenderer 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 Tenderer 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 Tenderer 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 operational testing of all the network elements has to be demonstrated by the Tenderer to the satisfaction of the utility.

8.12.5.4 The Tenderer 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.

ix. 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.

x. The Tenderer shall ensure data integrity checks on all metered data received from data collection systems.

xi. 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.

8.12.6 Climatic Condition

The meters to be supplied against this specification shall be required to operate satisfactorily and continuously under the following tropical conditions of hot, humid, dusty, rust and fungus prone environment.

Maximum ambient air temperature (°C)	55
Minimum ambient air temperature (°C)	(-) 5
Average Daily ambient air temperature (°C)	32
Maximum Relative Humidity (%)	95
Minimum Relative Humidity (%)	10
Maximum altitude above sea level (m)	1000
Average Annual Rainfall (mm)	1200
Maximum Wind Pressure (Kg/sq.m)	195
Isoceraunic Level (days per year)	50
Seismic Level (Horizontal Accn. In g)	0.3

8.12.7 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.

8.12.8 Testing

8.12.8.1 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.

8.12.8.2 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.

8.12.8.3 Acceptance Tests for PC Software and data down loading using meter communication ports- All IEMs after final assembly and before dispatch from Tenderer'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.

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

8.12.8.5 Downloading meter data through USB port and RS 232.

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

8.12.8.7 Compatibility with PC Software.

8.12.8.8 Functioning of Time synchronisation, advance and retard time commands.

8.12.8.9 Per meter downloading time verification.

8.12.9 Copy of Certificate shall be submitted.

8.12.9.1 Type Tests

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 Tenderer 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.

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 Tenderer shall provide their replacements at no extra cost to Owner.

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

Copy of Test certificate shall be submitted to SLDC.

8.12.10 ANOMALY DETECTION FEATURES

8.12.10.1 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.

8.12.10.2 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.

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

8.12.10.4 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.

8.12.10.5 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:

8.12.10.6 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.

8.12.10.7 Feeder Supply Fail -This event shall be logged when feeder supply, i.e., all the voltages goes below certain threshold. No snapshot shall be logged with this event.

8.12.10.8 Last three hundred & fifty (350) events (occurrence + restoration), in total, shall be stored in the meter memory on first in first out basis.

8.12.10.9 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

8.12.10.10 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.

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

8.12.11 Installation and Commissioning

8.12.11.1 The Tenderer shall be responsible for total installation and commissioning of the meters (along with test blocks, if supplied separately) as per Owner's advice, including unpacking and inspection on receipt at site, mounting the meters on control and relay panels at an appropriate viewing height, connection of CT and VT circuits including any required rewiring, functional testing, commissioning and handing over. The Tenderer's personnel shall procure/carry the necessary tools, equipment, materials and consumables (including insulated wires, lugs, ferrules, hardware etc.)

8.12.11.2 As part of commissioning of DCDs the Tenderer shall load the software specified in clause 5(d) into the PCs at the respective substations, and fully commission the total meter reading scheme. He shall also impart the necessary instructions to substation engineers. At least 2-hour training session shall be arranged for substation staff and SLDCs. Also, an operating manual (pdf as well as hard copy) of the meter containing all details of the meter, various data downloading features, etc. shall be made available at site and SLDC.

8.12.11.3 At the time of commissioning, the meters lying in stores shall be time synchronized through GPS signal before installation in the panel to avoid the large time mismatch.

8.12.12 General

8.12.12.1 The meter shall be supplied with latest/compatible software (shall be compatible with old & new meters data download handling). Any new software as required to be installed within warranty period are to be done by party or through remote support to client.

8.12.12.2 The total arrangement shall be such that one (1) operation (click on "data down load from meter" button on software) can carry out the whole operation in about five (5) minutes per meter or preferably faster.

8.12.12.3 The layout of software front end/user interface has to be approved by RLDC during technical evaluation/demonstration. However, a standard template sheet will be provided along with TENDER for reference.

8.12.12.4 Software for windows/office/antivirus to be supplied. Antivirus should not slow down processes and same will be demonstrated during technical demonstration.

8.12.12.5 Above specification is minimum only, any higher standard required for the purpose intended (meter data handling) would be assessed by vendor and would be supplied accordingly. The detailed architecture shall be approved during drawing approval stage.

8.12.12.6 Meter shall be accommodated in existing C&R panel of standard size (Alstom/ ER/ABB/Siemens/ERL) in kiosk or C&R panel with door closed. If required before Tendering, Tenderer may collect necessary data or else the scope is deemed to be included.

8.12.12.7 Step by Step procedure (on screen shot type and desktop video capture) shall be provided for

- Installation/Re-installation of Database handling software in to Laptop / PC
- Meter maintenance/site-testing procedure as per relevant IS/IEC standard
- Procedure for data downloading from Meter by HHU/Laptop/Desktop PC.

  As on date of delivery, the supplied meters shall comply with all statutory regulation as required under CERC/CEA/IEGC as applicable and the same should be declared by the vendor during delivery along with warranty certificate.

8.12.13 STANDARDS TO BE COMPLIED WITH

Standards to be complied

Sl. No	Reference	Reference Title
	Detail	
1	IS-15959:2011	Data Exchange for Electricity Meter Reading Tariff &
		Load Control – Companion Specification
2	IS-14697:1999	Specifications for AC Static Transformer operated Watt
		Hour & VAR-Hour meters, class of 0.2S and 0.5S
3	IEEE 830-1998	IEEE Recommended Practice for Software
		Requirements Specifications

8.12.14 System Security& Cyber Security

8.12.14.1 The Contractor shall document and implement a Cyber Security Policy in line with CERT-In latest guidelines (http://www.cert-in.org.in) to secure the system and the Contractor shall keep updating the Security settings as per the revised guidelines of CERT-In at time to time. Below listed basic strategies shall be followed by the Contractor for making the entire Control Centre immune to Cyber-attacks.

8.12.14.2 All the Hardware, OS and application software shall be hardened.

8.12.14.3 Network partition and DMZ through use of Firewall as required maximizing the security of ABT, OA AND MIS System while facilitating access for data and information to all stake holders.

8.12.14.4 All default user id & passwords shall be changed.

8.12.14.5 All log in/log out and cable plug in/plug out shall also be logged in the System.

8.12.14.6 Prevent unauthorized users from reading or writing data or files, executing programs or performing operations without appropriate privileges

8.12.14.7 Document all user sign on procedure

8.12.14.8 Record all network traffic for detecting unauthorized activity, unusual activity and attempts to defeat system security (Contractor to propose and document what constitutes normal activity/traffic)

8.12.14.9 Vendor has to identify and list the entire network and other protocols that communicate with physical systems and limit what is not required.

8.12.14.10 Network Zoning shall be implemented as per the proposed architecture given in Fig.1. However, the Contractor may suggest other methods of network architecture without compromising the security of the System.

8.12.14.11 No user shall be allowed to access remote network zones other than the adjacent zone.

8.12.14.12 Latest Cyber Security Guidelines of CERT-In specified at (http://www.cert-in.org.in) shall be followed.

8.13.0 RELAYS

8.13.1 GENERAL

8.13.1.1 All relays shall conform to the requirements of IS 3231/IEC 60255/ IEC 61000 or other relevant Standards.

8.13.1.2 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.

8.13.1.3 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.

8.13.1.4 Relays shall be suitable for flush mounting with connectors from rear.

8.13.1.5 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 modularcases.

8.13.1.6 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.

8.13.1.7 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.

8.13.1.8 No control relays that shall trip the circuit breaker when the relays are de-energized shall be employed in the circuits.

8.13.1.9 All relays shall withstand a test voltage of 2.5 kV, 50 Hz r.m.s. voltage for one second.

8.13.1.10 All protective relays and alarm relays shall be provided with two extra isolated pair of contacts wired terminals exclusively for Employer's use.

8.13.2 GENERAL SPECIFICATION OF NUMERICAL RELAYS

8.13.2.1 Numerical Relays shall be provided for the following applications:

Distance Protection for220KV, 132 kV and 66 kV Lines

As per MoM of 'CEA's third meeting of subgroup for preparation of Reliability Standards for Protection and communication system' and NERPC 47th PCC meeting' for 132kV or above voltage

level, transmission line length less than 10ckt.Km, Line Differential Relay (87L) shall be used as main protection instead of distance protection relay (21)

Backup directional over current and earth fault relays for 220KV, 132 kV and 66 kV Lines

8.13.2.2 All Numerical Relays should have following minimum features.

- Relays shall be communicable on IEC61850 protocol without any protocol converter. Certificates 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 backup to keep the internal clock running for atleast 2 years in absence of auxiliary supply.
- Should have minimum 16 configurable LEDs.
- Should have minimum 16 Binary Inputs and 24 Binary Outputs subject to the availability of 6 BI and 10 BO as spares above the system requirements.
- All BI/BOs shall be configurable
- Shall have front minimum 4 lines LCD display with suitable key pad for HMI operation for setting, configuration change etc.
- Numerical relays are 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) with the help of independent function blocks and Boolean logic.**
- Configured features & set values shall be in non- volatilememory
- Must have real time clock for time stamping of events/ disturbances with time synchronization inputs (GPRS etc.). Time synchronisation shall be 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.

8.13.2.3 Hardware based measurement shall not be acceptable.

8.13.2.4 The relay should have high immunity to electrical and electromagnetic interference.

8.13.2.5 The same relay shall be provided with both 1A and 5A CT inputs and shall be site selectable.

8.13.2.6 It shall be possible to energise the relay from either AC or DC auxiliary supply. Auxiliary dc supply shall be suitable for both110 or 220 Volt and shall be site selectable.

8.13.2.7 **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.

8.13.2.8 **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 customised 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.

8.13.2.9 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

8.13.2.10 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 with1ms resolution.

Disturbance records – The relay shall have capacity to store disturbance records of atleast 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 /Laptop.

8.13.2.11 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 from local as well as remote terminal through the communication port.

8.13.2.12 The Numerical relays shall be provided with 2 sets of common support software compatible with latest version of Windows which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, and measurements. The relay settings shall also be changed from local or remote using the same software**.**

8.14.0 <u>Transmission Line Protection:</u>

8.14.1 DISTANCE PROTECTION RELAY

8.14.2 The distance protection relay shall be fully numerical using microprocessors and be based on a non-switched scheme.

8.14.3 The distance protection relay shall have at least three completely independent non-switched forward directional zones, one extended zone and a reverse directional zone protection.

8.14.4 Have non-switched measurement, which implies processing of six possible fault loops (six –loop measurement)

8.14.5 Have polygonal characteristics with independently adjustable reactive and resistive reaches for maximum selectivity and maximum fault resistance coverage. The zones shall have independent settable earth fault compensation factors to cater to adjacent lines with different zero sequence to positive sequence ratios.

8.14.6 Selection shall be so that the first zone of the relay can be set to about 80% - 85% of the protected line without any risk of non-selective tripping.

8.14.7 The second and third zone elements shall provide backup protection in the event of the carrier protection or the first zone element failing to clear the fault, zone-2 shall cover full protected section plus50 % of the next section zone-3 shall normally cover the two adjacent sections completely. The zones must have independent time settings.

8.14.8 Have adequate number of forward zones (minimum three) and a reverse zone. The zone reach setting ranges shall be sufficient to cover line lengths appropriate to each zone. Carrier aided scheme options such as permissive under reach, over reach, & blocking and non-carrier aided schemes of zone 1extension and Loss of load accelerated tripping schemes shall be available as standard. Weak in feed logic and current reversal guard also shall be provided.

8.14.9 In case the carrier channel fails, one out of the non-carrier-based schemes cited above should come into operation automatically to ensure high speed and simultaneous opening of breakers at both ends of the line.

8.14.10 Have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) for SIR 0.01-4: as 40ms at the nearest end and 60ms at the other end of line & for SIR 4-15: as 45ms at the nearest end and 65ms at the other end of line with carrier transmission time taken as 20ms.

8.14.11 Have a secure directional response under all conditions, achieved by memory voltage polarising and /or healthy phase voltage polarising as appropriate.

8.14.12 Shall have an independent Directional Earth Fault (DEF) protection element to detect highly resistive faults. This element shall have an inverse time/definite time characteristic.

8.14.13 Has logic to detect loss of single /two-phase voltage input as well as three-phase voltage loss during Energisation and normal load conditions. The voltage circuit monitoring logic in addition to blocking the distance protection element, enable an emergency over current element to provide a standby protection to the feeder until the re-appearance of voltage signal.

8.14.14 The VT fuse failure function shall function properly irrespective of the loading on the line. In other words, the function shall not be inhibited during operation of line under very low load conditions.

8.14.15 Have necessary logic to take care of switch-on-to-fault condition. Energisation of transformers at remote line ends and the accompanying inrush current shall not cause any instability to the operation of relay.

8.14.16 Have power swing blocking feature, with facilities for fast detection of power swing selective blocking of zones settable unblocking criteria for earth faults, phase faults and three phase faults

8.14.17 Be suitable for single pole or three pole tripping.

8.14.18 Be suitable for both bus PT or Line PT/ CVT supply.

8.14.19 Shall have in built Trip circuit supervision facility to monitor both pre- and post-close supervision facilities. An alarm shall be generated.

8.14.20 Shall have in built broken conductor detection

8.14.21 The sensitivity of the logic shall not be affected during operation under low load.

8.14.22 Shall have a fault locator with an accuracy of ±3%. The display shall be in kilometres or percentage impedance. The fault locator should have built in mutual compensation for parallel circuit.

8.14.23 **The relay shall have a built-in auto-reclose function with facilities for single pole/ three pole / single and three pole tripping. It shall be possible to trigger the A/R function from an external protection**. A voltage check function which can be programmed for dead line charging/dead bus charging / check synchronising shall be included.

8.14.24 Shall have additional features to provide under/ over voltage protection

8.14.25 Shall have additional features to provide under frequency protection

Technical Parameters

Power supply module

a) Aux. DC Voltage - 110/220 V DC
b) Permissible tolerance - + 20%
c) Power consumption - 15 to 40 W

Analog inputs

a) Current - 1A CT < 0.5VA
b) AC voltage - 110V PT, < 0.5VA
c) Permissible overload - CT 4A cont. PT 230V Cont.
d) Frequency - 50 Hz, + 5%

Distance protection Zones

a) No. of zones - Five, selectable direction
b) Characteristic - Quadrilateral and/ or mho (selectable)
c) Minimum operate current - (10-30) % of In
d) Xp Setting Range - 0.5 to 250_/Ph
e) Rp Setting Range - 0.1 to 250_/Ph

f) Xo Setting Range - 0.5 to 250_/Ph
g) Ro Setting Range - 0.5 to 250_/Ph
h) Angle - 100 to 850
i) Zone timers - 0 – 30 s, + 10 ms
j) Operate time - @ 25 ms
k) Reset ratio - 105% for DPR 95% for SOTF
l) Reset time - 40 ms

Binary inputs Module

a) Binary inputs - 24 (freely assignable to any function)
b) DC Voltage - 110/125 V DC, + 20%
220/250V, + 20%
c) Power consumption - Max 0.2 W/Input-110V

8.14.26 Line Differential Protection Relay (If Applicable)

***NOTE: the 'Main I and Main II Line Differential Protection scheme (with Distance protection function as back up) is applicable for 220 kV voltage level only. For 132 kV voltage level only 'Main I Differential Protection scheme (with Distance protection function as back up)' is envisaged.**

Main I and Main II Line Differential Protection shall be of two different makes (i.e., from different manufacturers) or of same make with two different platforms with same specifications.

The relay shall have all the features as per Distance protection relay over and above following features

1. It shall be working on phase segregated Current Differential protection principle.
2. It shall have multiple slope characteristic (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults.
3. It shall measure Differential as well as restrain current continuously and shall display the same as measurement.
5. It shall communicate to remote end through IEEE C37.94 format.
6. It shall have redundant communication channels for protection communication.
7. It shall communicate analogue as well as digital signals to remote end.
8. It shall have various communication options for remote communication i.e. mono-mode / multi-mode for direct communication / communication through multiplexer.
9. It shall have Line charging current compensation feature for better sensitivity.
10. Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication. .It shall have a full scheme distance protection scheme to provide independent protection in parallel with the differential scheme in case of a communication channel failure for the differential scheme. The distance protection then provide protection for the entire line including the remote end back up capability either in case of a communications failure or via use of an independent communication channel to provide a fully redundant scheme of protection (that is a second main protection scheme). Eight channels for intertrip and other binary signals are available in the communication between the IEDs. The auto-reclose for single-, two- and/or three phase reclosing includes priority circuits for multi-breaker arrangements. It co-operates with the synchronism check.
11. It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately. Time synchronization through GPS shall also be possible.
12. It shall monitor individual communication links continuously and switchover to standby link after preset time in case of failure of one link.
13. It shall supervise individual telegrams.
14. It shall detect reflected telegrams.
15. It shall detect change in communication It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm.
17. It shall also supervise maximum permissible delay time.
18. It shall generate alarm for heavily disturbed communication link. Technical Parameters

A. Line Differential Protection setting:

1. Minimum operating current - 20 to 200% of In
2. Slope (Single/dual) - 10 to 100%
3. End section (Single/dual) - 20 to1000% of In
4. Highset operating current - 100 to 5000% of In

5. 2 nd Harmonic blocking - 5 to100 %
6. Typical operating time - 25 ms
7. Operating time for high set - 15 to 20 ms
8. Charging current comp. – Selectable

B. Remote communication:

9. Analogue signal transfer – Minimum 3 Nos.
10. Binary signal transfer - Minimum 8 Nos
11. Remote Communication module
    Dual modules suitable for
    a) 1300 nm - multi-mode OR b) 1300 / 1550 nm – mono-mode (finalized during detailed engineering)
12. Synchronization mode - GPS / Echo (finalized during detailed engineering)
13. Time delay alarm - 5 to 500 ms, step 5 ms (for communication fail)
14. Time delay - 5 to 500 ms, step 5 ms (for switching to redundant channel)
15. Asymmetric delay - - 20 to +20 ms, step 1 ms (When echo mode is used)
16. Max. Transmission delay – 0 to 40 ms, step 1 ms.

8.15.0 OVER CURRENT AND EARTH FAULT RELAYS

8.15.1 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:

(a) IDMT characteristic with definite minimum time of 3 second at 10 times setting. Other operating curves such as inverse, very inverse shall be selectable
(b) Adjustable setting range of 50-200 % and 20-80% of rated current for over current and earth fault relays respectively.
(c) 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
(d) Voltage polarizing coil: 63.5 or 110 volts
(e) Must have faulty phase, type of fault identification
(f) The directional relays shall have over voltage/ under voltage & under frequency built in protection shall be draw out type.

Directional O/C & E/F PROTECTION

(A) Features:

a) Shall be Numerical type.
b) Shall have 2 over current and 1 Earth Fault element.
c) TRUE RMS Measurement.
d) Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.
e) Selectable CT Secondary. I.e. 1A / 5A
f) High set over current with selectable time delay.
g) High set Earth fault with selectable time delay
h) Have adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively.
i) Shall decide directionality by internally derived zero sequence quantity through software.
j) Shall have in built Breaker Failure Protection.
k) Include hand reset Flag/LED indicators for fault.
l) Readable Human Machine Interface with LCD display.
m) Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc. with time-stamp.
n) Shall have Disturbance Recording facility for minimum 3 sec for each fault.
o) Self-monitoring.
p) Relay offered shall be communicable type.
q) Be supplied along with all suitable **Original Customized licensed software & communication cable** for local and remote communications, analysis of fault etc.

(B) Technical Parameters:

1. Analogue input:
   Rated Current: 1A / 5A (site selectable), 50 Hz ±2.5 Hz

Power consumption: <0.05VA/0.3 VA for 1/5 Amp
Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic
Rated Voltage: 110/63.5V, 50 Hz ±2.5 Hz
Power consumption: <0.3 VA per phase
Over load capability: 2xVn continuous

2. Auxiliary Supply: 110/220 V DC ±15 %
Power consumption: < 15W
Ripple (peak to peak): < 12%

8.16.0 TRIP CIRCUIT SUPERVISION RELAY

8.16.1 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.

8.16.2 The relay shall have adequate contacts for providing connection to alarm and event logger.

8.16.3 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.

8.17.0 MASTER TRIP RELAY

8.17.1 High Speed Tripping Relay shall be instantaneous (operating time not to exceed 10 milli-seconds

8.17.2 The relays shall reset within 20 milli seconds

8.17.3 The relay shall be re-settable/configurable from local SCADA.

8.17.4 The relays shall be D.C. operated

8.17.5 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.

8.17.6 The relays shall be provided with operation indicators for each element/coil.

8.18.0 DC SUPPLY SUPERVISION RELAY

8.18.1 The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

8.18.2 It shall have adequate potential free contacts to meet the scheme requirement.

8.18.3 The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and

8.18.4 The relays shall be provided with operation indicator/flag.

8.19.0 TIME SYNCHRONISATION EQUIPMENT

8.19.1 The Time synchronisation equipment shall receive the coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronise equipment to the Indian Standard Time in a substation.

8.19.2 Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

8.19.3 It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

8.19.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity

8.19.5 The synchronisation equipment shall have 2 micro second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperaturevariations, propagation & processing delays etc.) Including communication time for satellite link to achieve real time signal.

8.19.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.

8.19.7 The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

8.19.8 The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

8.19.9 The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following:

8.19.10 1) Voltage signal: Normally 0-5V with 50 milli Seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
2) Potential free contact (Minimum pulse duration of 50 milli Seconds.)
3) IRIG-B
4) RS232C

8.19.11 The equipment shall have a periodic time correction facility of one-second periodicity.

8.19.12 Time synchronisation equipment shall be suitable to operate from 80V-250V DC supply available at the sub-station with voltage variation of + 10% and -15%.

8.19.13 Equipment shall have real time digital display in hour, minute, second (24-hour mode) & have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 Mm height.

8.19.14 The cable connecting Antenna and Time Synchronising unit should be run through HDPE pipe or GI Pipe from the location of Antenna fixing to Time Synchronising panel with suitable fixtures and no provision to enter rainwater and should not be affected by atmospheric conditions.

8.19.15 The equipment shall also have real time display in hour, minute, second, mili seconds. (24 hours mode) and shall have a separate time display unit to be mounted on the top of control panels having display size of approximately 144 mm height. The equipment shall have periodic time correction facility of 1(one) second periodicity.

8.20.0 PROTECTION SCHEME FOR PANELS

8.20.1 132 kV LINE PANEL

The following protections scheme shall be provided for Panels for 132 kV Transmission lines:

a) Main Protection Scheme:

Distance protection scheme/Line Differential protection scheme using Numerical Relay as specified in ***Clause 8.14.0***.

The complete scheme shall have following features

(i) Permissive under reach transfer trip principle.
(ii) Suitable for single cum three phase tripping.
(iii) Power swing blocking.
(iv) Single shot single-cum-three phase/three phase auto re-closing with check synchronising and dead line charging features.
(v) Fuse failure protection.

b) Backup Protection:

The backup protection shall be provided with directional single/ multi pole relays as specified in ***Clause 8.15.0***

One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults without high set elements shall be provided.

8.21.0 RELAY TESTING SETS & MAINTENANCE TOOL KIT

8.21.1 TESTING SET

8.21.1.1 The bidder shall supply one set of testing set (if specified in the Schedule of Quantity) for dynamic and static testing of all the relays, they intend to supply. The testing sets along with literature and brochure are to be dispatched to the departmental commissioning authority, Office of the Superintending Engineer, MRT Circle, AEGCL, Narengi, Guwahati - 781026.

8.21.2 The equipment shall be supplied from reputed manufacturer. It should be got approved before inspection. Standard acceptable makes are Freja / Omicron / Doble / MPRT / Manta / EUROSMC /KOCOS. It shall have provision for energy meter testing capability.

8.21.3 The testing set shall be microprocessor based. It shall have provision for energy meter testing capability. Necessary software, test leads, leads for lap top interface shall be included with the testing set.

8.21.4 The relay testing set shall have Ethernet/ USB interface with Work station/ Lap top

8.22.0 MAINTENANCE TOOL KIT

8.22.1 The bidder shall supply (if specified in the Schedule of Quantity) a complete maintenance tool kit along with the testing set. The tool kit shall have current jack, card extender, card puller, required crimping tool, screw drivers, pliers etc.

8.22.2 The tool kit shall contain test plugs, test leads, clips for maintenance and testing of relays supplied.

8.23.0 TESTS

8.23.1 The CONTRACTOR shall carryout all tests as per relevant standards as all associated equipment including relays, meters, instruments etc. The CONTRACTOR shall submit all that reports to Employer for approval before dispatching 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.

8.23.2 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,ERL, GE and SEL)

8.24.0 PRE-COMMISSIONING TESTS

8.24.1 The contractor shall have to perform following minimum Pre-commissioning tests for commissioning of the C&R panels. For this purpose, the contractor shall arrange all required tools and testing equipment at site:

- IR values of all circuits
- Measurement of burden in CT & PT circuits.
- Primary current injection of CT circuits with connected burden
- Energization of PTs at suitable low voltage and measurement of PT inputs at all measuring points
- 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.
- 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
- Checking of Boolean logic gates, BI/BO points of the numeric relays, checking conformity to specification and checking of set logics
- 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.
- Checking stability & sensitivity of bus differential relay zones by suitably injecting current
- Checking registration of event and disturbance records in the numeric relays and down loading
- Testing of AR schemes
- Checking of healthiness of each dc circuit of panels
- Simulation of faults like Buchholz, OTI, WTI and other relays and checking of tripping of breaker and connected annunciation
- Operation of master trip relays, tripping of breaker through each trip coil and checking of interlocks
- Simulation of faults like low gas, air pressure and checking operation of inter locks. Checking anti pumping scheme of CB
- Simulation to Check Checking of PT selection schemes
- Simulation to Check interlocks of all CB and isolator inter locks
- Simulation to Check annunciation of all events in BCU (Bay control unit) as well as SAS (Sub-station Automation System)
- Simulation to Check of logic of BCU

8.24.2 The pre-commissioning checklist will be further developed by the contractor and will seek approval prior to commencement of pre-commissioning tests from the DGM, MRT Circle. The tests will be witnessed and approved by him or by his authorized officers.

8.25.0 TECHNICAL DATA SHEET FOR THE RELAY AND CONTROL PANELS

8.25.1 Features to be provided in various Relay and Control panels are indicated below.

Descriptions 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	Rating & Particulars
1	**Protection & relays:** **(for 132 V Panel with single Bus system):** **132 kV LINE PANEL (with automation)**	
	(a) Distance protection scheme as per clause 8.14.0.	1 No
	(b) Back up directional over current and earth fault scheme as per Clause 3.9.13.30	1 No
	(a) LBB Protection Scheme.	Can be a function of BCU/IEDs
	(b) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 2(two) trip coils
	(c) DC Supply healthy monitoring scheme	1 No
	(d) AC Supply healthy monitoring scheme	1 No
	(e) High Speed Trip relay	2 Nos.
	(f) Auxiliary relay, timer relay for healthiness of relays, trip transfer, auto reclose communication link etc.	As required (Can be function of BCU)
	(g) Line CVT-Bus PT selection relay	1 No
	(h) Synchronising Scheme	1 No (Can be function of BCU)
2	(i) Meters	
	(a) ABT compliant tri-vector Meter as per Clause 8.12.0	1 No
3	Control/Status indication/annunciation	
	(a) Bay Control Unit (IED with HMI)	1 No (Function of BCU/SAS)
	(c) Ethernet switch for connecting to existing ring LAN of SAS	1 No

9.1.0 General

9.1.1 The new bay shall have the provision to integrate with the existing Substation Automation System which is under implementation at 220 KV Sonapur S/S to control and monitor all the equipment(s) of the new line bay from remote control centre as well as from local control centre.

9.1.2 Bay level intelligent electronic devices (IED) for protection and control and the Managed Ethernet Switch shall be provided in the C&R panels installed in the local control room. Each IED will be directly connected to the Hot-standby Server PC (HMI) of the Sub-Station Automation System through a Double Fault Tolerant Ethernet LAN on fibre optic medium and shall communicate as per the IEC61850 standard.

9.1.3 The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

9.1.4 All the numerical IEDs must be fully IEC 61850 compliant and must have the following features.

- Have peer-to-peer communication using GOOSE messages (IEC 61850) for interlocking.
- Should be interoperable with third party IEC 61850 compliant devices
- Should generate XML file for integration/engineering with vendor independent SCADA systems.
- **Should be directly connected to the inter bay bus on IEC 61850 without the use of any gateways.** Connections of bay protection IEDs to the IEC 61850 bus through the bay control units is not acceptable.

9.2.0 Bay Level Unit / Bay Control Unit

9.2.1 The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. These shall incorporate select-before-operate control principles as safety measures for operation via the HMI. These shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. These shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, these shall receive the operation commands from station HMI and SLDC. The bay unit shall have the capability to store all the data for at least 24 hours.

9.2.2 One Bay level unit shall be provided for supervision and control of 220KV OUTDOOR GIS bay (a bay comprises of one circuit breaker and associated disconnectors, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

9.2.3 The Bay level units shall be installed in the control and relay panels located in the control room.

9.2.4 The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

9.3.0 Input / Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of SF6 Gas Pressures, Operating Mechanism Pressures, WTIs, OTI etc. are received through transducers to Bay Level Unit

The digital inputs shall be acquired by exception with 1ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

SECTION-10
TECHNICAL SPECIFICATION OF POWER AND CONTROL CABLES

10.1.0 GENERAL REQUIREMENT

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

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

10.1.3 Cables shall be laid conforming to IS: 1255.

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

- Separate cables shall be used for AC & DC.
- For different cores of CT & PT separate cable shall be used.
- At least one (1) core shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

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

10.1.6 Standard technical data sheets for cable sizes up to and including 1100V are enclosed at **Clause 10.3.0**. Cable sizes shall be offered /manufactured in accordance with parameters specified in standard technical data sheets. Technical data sheet for any other cores/sizes required during detailed engineering shall be separately offered for Employer's approval by the contractor/supplier.

10.2.0 TECHNICAL REQUIREMENTS

10.2.1 General

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

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

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

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

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

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

10.2.1.7 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.

10.2.1.8 All the cables shall pass fire resistance test as per IS:1554 (Part-I)

10.2.1.9 The normal current rating of all PVC insulated cables shall be as per IS: 3961.

10.2.1.10 Repaired cables shall not be accepted.

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

10.2.2 XLPE Power Cables

The XLPE (90°C) insulated cables shall be of FR type, C1 category conforming to IS: 7098 (Part-I) and its amendments read along with this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS: 5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS: 5831 for all XLPE cables.

10.2.3 PVC Power Cables

10.2.3.1 The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read along with this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS 5831 for all cables.

10.2.4 PVC Control Cables

10.2.4.1 The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.

10.2.4.2 Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS 1554 (Part-1).

10.3 DATA SHEET FOR CABLES

(A) Power Cables

Sl. No.	Description	3 ½ C 300mm$_2$	Other Power Cables	
			70 mm$_2$, 35 mm$_2$, 25mm$_2$, 16 mm$_2$	6 mm$_2$& 4mm$_2$
1	Applicable Standard	IS: 7098/PT-I & its referred standards	IS: 1554/PT-I& its referred standards	
2	Type Designation	A2XWY	AYFY	AYWY
3	Rated Voltage(volts)	1100	1100	1100
4	Type & Category	FR & C1	FR & C1	FR & C1
5	Suitable for earthed or unearthed system	Suitable for both		
6	Conductor			
	a) Material	Stranded Aluminium as per IS : 8130		
	b) Grade	H 2 (Electrolytic grade)		
	c) Number of wires (No.)	As per IS 8130		
	d) Form of Conductor	Stranded compacted circular/sector shaped	Stranded compacted circular/sector shaped	Non- compacted Stranded circular
	e) Direction of lay of stranded layers	Outermost layer shall be R.H lay & opposite in successive layers		
7	Insulation			
	a) Composition of insulation	Extruded XLPE as per -7098 Part (1)	Extruded PVC type A as per IS- 5831	Extruded PVC type A as per IS-5831
	b) Thickness of insulation(mm)	As per applicable Standard		
8	Inner Sheath material	Extruded PVC type ST-2 as per IS-5831	Extruded PVC type ST-1 as per IS- 5831	
9	Type and material of armour	Gal. Steel wire	Gal. Steel strip	Gal. Steel wire
10	Outer Sheath (PVC)	ST-1 & FR	ST-2 & FR	ST-2 & FR
11	Overall diameter of cable	As per applicable Standard		

(B) Control Cables

Sl. No.	Description	Particulars
1	Applicable Standard	IS: 1554/PT-I & its referred standards
2	Type Designation	YWY
3	Rated Voltage(volts)	1100
4	Type & Category	FR & C1
5	Suitable for earthed or unearthed system	Suitable for both
6	Conductor	
	a) Material	Plain annealed High Conductivity stranded Copper (as per IS 8130)
	b) Grade	Electrolytic
	c) Number of wires(No.)	As per IS 8130
	d) Form of Conductor	Non-compacted Stranded circular
	e) Direction of lay of stranded layers	Outermost layer shall be R.H lay
7	Insulation	
	a) Composition of insulation	Extruded PVC type A as per IS-5831
	b) Thickness of insulation(mm)	As per applicable Standard
8	Inner Sheath material	Extruded PVC type ST-1 as per IS-5831
9	Type and material of armour	Gal. Steel wire
10	Outer Sheath (PVC)	ST-1 & FR
11	Overall diameter of cable	As per applicable Standard
12	No. of Cores	As per Bill of Materials

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SECTION-11

TECHNICAL SPECIFICATION FOR 33 KV, 132KV, 220KV & 400 KV CVT & IVT

11.1. SCOPE:

11.1.1. This specification provides for the design, manufacture, assembly inspection and testing at the manufacturer's works, packing and delivery at site, erection, testing and commissioning of outdoor mounted type, single phase, oil filled, self-cooled, single unit type Inductive voltage transformers for 33 KV &132KV systems, & Capacitive Voltage Transformers for,132KV, 220kV & 400 KV system to be used for voltage indication, supply of potential to energy meters, relays for feeder protection in Grid Sub- stations of AEGCL, ASSAM.. In addition to the above functions the 400 KV, 220kV, 132KV CVT shall be suitable for carrier coupling.

11.1.2. The IVTs shall be complete in all respects with insulators, bimetallic connectors, fixing details etc. as described herein.

11.1.3. Bidders are required to quote for 0.2 accuracy class [metering winding] for 33 KV and 132KV IVTs & 132KV, 220kV, 400kV CVTs in the following manner.

(a) Guaranteed Technical Particulars.

(b) Technical literatures, brochures and drawings as per this specification.

(c) Type Test reports.

(d) List of orders, executed and Users' certificates with **minimum 5years of field proven experience** failing submission of the above particulars with the offer, the tender may not be considered for evaluation.

11.2. Following is the list of documents constituting this Specification:

(i) Technical Specification (TS).

(ii) Technical requirements.

11.3. STANDARDS:

13.3.1 The IVTs & CVTs shall conform in all respects to high standards of Engineering, design, workmanship and latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or material which in his judgement is not in full accordance therewith.

13.3.2. Except to the extent modified in the specifications, the IVTS & CVTs shall conform to the latest editions and the amendments of the standards listed hereunder:

Sl. No.	Standard Ref. No.	Title
01	IEC-44(4)	Instrument Transformer – measurement of PDS.
02	IEC-60	High voltage testing techniques.
03	IEC-171	Insulation co-ordination.

04	IEC-186	Voltage Transformers.
05	IEC-186(A)	Voltage Transformers (first supp. to IEC-186)
06	IEC-270	Partial discharge measurement.
07	IS-335	Insulating oil for transformers and switchgears.
08	IEC-8263	Method for RIV Test on high voltage insulators.

09	IS-2071	Method of high voltage testing.
10	IS-2099	High Voltage porcelain bushings.
11	IS-2147	Degree of protection provided by enclosures for low voltage switchgear and control.
12	IS-2165	Insulation co-ordination for equipments of 100KV and above.
13	IS-3156 (Part-I to IV).	Voltage transformers.
14	IS-3347	Dimensions of porcelain transformer bushings.
15	IS-4146	Application guide for voltage transformers.
16	IS-5547	Application guide for Capacitor Voltage Transformers.
17	IS-9348	Coupling Capacitor & Capacitor Devices.

13.3.3 All the above along with the amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this Technical Specification will prevail.

13.3.4. The voltage transformers with the requirements of other authoritative standards, which ensure equal or better quality than the standards, mentioned above shall also be acceptable. Where the equipments, offered by the supplier conform to other standards, salient points of difference between the standards shall be brought out in the offer. 4 (four) copies of the reference standards in English language shall be furnished along with the offer.

The supplier is to furnish the standards as mentioned above from Sl. 1 to 17 at their own cost, if required by the purchaser.

Accuracy specified shall be maintained at 25% of rated burden.

11.4. CLIMATIC AND SERVICE CONDITIONS:

11.4.1 Earthquake Incidence:

The CVT/VT are to be designed to withstand earthquake of intensity, equivalent to **minium** 0.5g in the horizontal and 0.6g in the vertical direction.

11.5. INSTALLATION:

The **CVT**/VT covered under this specification shall be suitable for outdoor installation without any protection from rain, dust, mist and direct rays of the sun.

11.6. GENERAL TECHNICAL REQUIREMENTS:

11.6.1. GENERAL TECHNICAL REQUIREMENTS FOR IVT:

11.6.1.1. Each IVT shall be supplied, filled with insulating oil and shall be hermetically sealed to prevent **atmospheric environment** in contact with oil, avoiding filtration and change of oil. Stainless steel diaphragm Bellow with bellow level indicator shall be provided.

11.6.1.2. Secondary Terminal Box:

11.6.1.2.1. The secondary terminals shall be brought out in a weatherproof terminal box with IP-55 **degree of protection enclosure.**

13.6.1.2.2 All secondary terminals shall be brought out in a compartment on one side of each IVT for easy access.

11.6.1.2.3. The exterior of this terminal box shall be hot dip galvanized.

11.6.1.2.4. The terminal box shall be provided with removable gland plate and glands suitable for 1100 volts grade. PVC insulated, PVC sheathed multi core of **2.5 sq.mm to 4 sq.mm** stranded copper conductor cable.

11.6.1.2.5. The terminal box shall be provided with a cover in front so as to have easy access of secondary terminals. The cover shall have a sealing/locking arrangement and shall be suitable to prevent penetration of moisture and rainwater.

11.6.1.2.6. The dimensions of the terminal box and its openings shall be adequate to enable easy access and sufficient working space for use of normal tools.

11.6.1.2.7. The terminal blocks shall be standard type and provided with ferrules indelibly marked or numbered and their identifications shall correspond to the designation on the relevant wiring diagram.

11.6.1.2.8. Secondary wiring terminal studs shall be provided with at least three nuts, plain and spring washers. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads.

11.6.1.2.9. Primary earthling link should be provided for measurement of capacitance & di-electric dissipation factor.

13.6.1.2.10 Polarity shall be indelibly marked on each primary and secondary terminal.

13.6.1.3 The IVT shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. The method adopted for hermetic sealing shall be described in the offer.

13.6.1.4. The castings of base, collar etc. shall be die cast and tested before assembly to detect cracks and voids, if any.

13.6.1.5. The characteristics of the IVTS shall be such as to provide satisfactory performance such as voltage error and phase displacement at rated frequency shall not exceed the values as per relevant standards at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden at a power factor of 0.8 lagging. The error shall be determined at the terminals of the IVT and shall include the effects of any fuses or resistors as an integral part of the IVT.

13.6.1.6. Inductive voltage transformers shall be ferro-resonance proof and adequately designed to use in HT cable circuit wherever applicable.

13.6.1.10. Primary Winding:

Primary winding of the IVT will be connected phase to neutral with the neutral point solidly earthed. The arrangement for this shall be included in the scope of supply. The primary conductor shall be of adequate cross-section so that the maximum permissible current density shall not be exceeded even during short-circuit conditions. Primary Windings shall be made of Copper.

13.6.1.11. Secondary Winding:

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. The secondary conductor shall be of adequate cross section so that the maximum permissible current density shall not be exceeded even during short-circuit conditions. Secondary windings details, burden & accuracy class are mentioned in Appendix-I. Secondary windings shall be used for metering, relaying and synchronizing. Each winding shall comply requirements of both Part-II and III of up-to-date editions of IS-3156/IEC-186.

13.6.1.12. Core:

Core laminations shall be of cold rolled grain-oriented silicon steel to ensure 0.2 accuracy class at both normal and over voltage. The core material, thickness of lamination, the relevant graphs showing the characteristics of the core materials shall be submitted along with the offer.

13.6.1.13. Tank:

13.6.1.13.1. Both expansion chambers and tanks of the IVT shall be made of high-quality steel and shall be able to withstand full vacuum and pressure, and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be hot- dip galvanized as per relevant standard.

13.6.1.13.2. The metal tanks shall have bare minimum number of welded joints so as to minimize possible locations of oil leakage. Welding in horizontal plane is to be avoided. Supplier has to obtain specific approval from the purchaser for any horizontal welding, used in the bottom tank

13.6.1.13.3. Paint inside the metallic housing shall be of anti-condensation type.

13.6.1.14. Porcelain Housing:

13.6.1.14.1. The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength; glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rainwater or condensed water particles (fog)

13.6.1.14.2. The bushings of the IVTS shall conform to latest edition of IS-2099.The hollow porcelain insulators shall conform to the latest edition of IS-5621

13.6.1.14.3. The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength

13.6.1.14.4. The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.

13.6.1.14.5. Cast metal and caps for the bushings shall be of high strength hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.

13.6.1.14.6. End shields should be provided for distribution of stresses.

13.6.1.14.7. Corona shields for bushings, if required, should be provided.

13.6.1.15. Insulating Oil:

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall comply in all respects with the provisions of the latest edition of IS-335. The IVTs shall be supplied filled with **new oil.**

13.6.1.16. Prevention of Oil Leakage and Entry of Moisture:

The supplier shall ensure that the sealing of the IVT is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings

(a) Locations of emergence of primary & secondary terminals.

(b) Interface between porcelain housing and metal tank(s).

(c) Cover of the secondary terminal box.

(d) Sealing around oil level indicator.

13.6.1.16.1. Nuts and bolts or screws used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.

13.6.1.16.2. For gasketed joints, wherever used, **nitrite butyl rubber/Neoprene gaskets shall be used**. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

13.6.1.17. Fittings and Accessories:

Fittings and accessories listed below shall be supplied with each IVT. Any fitting required essential other than those listed below shall also be supplied along with each IVT.

(a) Oil level gauge.

(b) Oil filling hole and cap.

(c) Pressure relieving device.

(d) Lifting lugs.

(e) Phase terminal connectors.

(f) Tank earthing pads/terminals with necessary nuts and bolts and washers for connecting to Purchaser's strip.

(g) Name/Rating plate.

(h) H.R.C. fuse of Adequate rating

i) Bellow

13.6.1.18. Provisions

13.6.1.18.1. Oil Level Gauge:

An oil level gauge shall be provided to indicate the oil level in the IVT. This gauge shall be mounted in such a way that the oil level can be seen from the ground level.

13.6.1.18.2. Pressure Relieving Device:

Each IVT shall be provided with a pressure relieving device so as to protect bushing of the IVT even under unfavourable conditions.

13.6.1.18.3. Oil Drain Cock:

An oil drain cock along with a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

13.6.1.18.4. Earthing: Metal tank of each IVT shall be provided with two separate earthing terminals for bolted connection to be provided by the Purchaser for connection to station earth-mat.

13.6.1.18.5. Lifting Arrangement:

The IVT shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing.

Lifting arrangement [Lifting eye] shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

13.6.1.18.6. Name Plate:

The IVT shall be provided with non-corrosive legible name plate with the information specified in relevant standards, duly engraved/punched on it.

13.6.1.18.7. Gasket Joint:

The manufacturer shall furnish the type of gasket used or setting

methods. 13.6.1.18.8. Terminal Connectors:

All the IVTs shall be provided with bimetallic solder less clamp type, rigid type terminal connectors, suitable for ACSR Conductor as per site requirement. Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors/station bus bar.

13.6.1.18.8.1. Terminal Connectors shall be manufactured and tested as per IS:5561.

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

13.6.1.18.8.3. No part of a clamp shall be less than 12mm. thick.

13.6.1.18.8.4. All ferrous parts shall be hot dip galvanized conforming to IS-2633

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

13.6.1.18.8.6. Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS-5561.

13.6.1.18.9. Secondary Wiring: The Secondary wiring shall be enclosed in conduits and shall be brought to a terminal block ready for external connections. The wiring shall be of adequate cross-section and not less than 2.5 sq.mm copper wire.

13.6.1.18.10. The supplier shall supply necessary hardwares, required for connection of phase side conductor to the line terminal and the grounding strip to the grounding terminal.

13.6.1.18.11. Necessary nuts and bolts for fixing the IVTS on the supporting structures shall be in tenderer's scope of supply.

11.6.2. GENERAL TECHNICAL REQUIREMENTS FOR 400KV, 220KV & 132KV CAPACITIVE VOLTAGE TRANSFORMER:

11.6.2.1. The CVT shall operate satisfactorily in system with high X/R ratio. (Tp=100 ms.).

11.6.2.2. The CVT transformer tanks along with top metallic shall be galvanized and painted to required shade.

11.6.2.3. Impregnation details along with tests and checks to ensure successful completion of impregnation cycle shall be furnished for purchaser's approval.

11.6.2.4. Bellows, if used to cater for expansion of insulating oil, shall be tested in accordance with relevant standards. The details shall be subject to the approval of the purchaser.

11.6.2.5. The CVT shall be capacitor voltage type with electromagnetic units and shall be suitable for carrier coupling.

11.6.2.6. All windings of voltage transformer secondaries shall be protected by HRC cartridge type fuses.. The secondary terminals of the CVTs shall be terminated to stud type non-disconnecting terminal blocks in the individual phase secondary boxes via the fuse. Fuse ratings shall be clearly mentioned.

11.6.2.7. CVTs shall be suitable for high frequency (HF) coupling, required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by meant of a RF choke/reactor, suitable for effectively blocking the carrier signal over the entire carrier frequency range i.e. 40 to 500 KHZ. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilized. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal**. Test tap for Tan- delta and capacitance shall be provided.**

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

11.6.2.9. The accuracy of the windings (0.2/3P/3P) shall be maintained throughout the entire burden range preferably in the frequency range of 48 HZ to 51.5 HZ on all the three windings without any adjustment during operation. Preference will be given to such bidders who can offer for maintaining the above accuracy class in the frequency range i.e. 48 HZ to 51.5 HZ up to the above specified burden values.

11.6.2.10. Constructional Features:

11.6.2.10.1. The 400KV, 220KV & 132KV CVT shall be suitable for mounting on support structure of lattice type structures.

11.6.2.10.2. Access to secondary terminals shall be possible without any danger of access to high voltage circuit.

11.6.2.10.3. CVTs shall be hermetically sealed units.

11.6.2.10.4. **A protective surge Arrester/spark gap shall be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. Surge arrester shall be provided in the secondary winding also.**

11.6.2.10.5. The CVT secondary terminals shall brought out into a weatherproof terminal box for ease of access. The terminal box shall have an IP rating of not less than IP 55. The terminal box shall be provided with a removable gland plate at the bottom and shall be suitable for accepting the required number of PVC insulated PVC sheathed, 10 core 2.5 mm² standard copper conductor cable.

11.6.2.10.6. All terminals shall be clearly marked to facilitate connection of secondary wiring.

11.6.2.10.7. Secondary fuses or MCBs shall be provided on or adjacent to each CVT, located such that they are accessible while the primary is live and shall be provided with labels indicating their function and their phase colours CVT secondary circuits shall be complete in themselves and shall be earthed at one point only. A separate earth link shall be provided for each secondary winding and shall be situated at the CVT. Primary earhing links should be provided.

13.6.2.10.7. To prevent ferro resonance, suitable damping devices shall provide for connection to the transformer secondaries.

13.6.2.10.8. CVTs shall meet the requirements, given in this section of the specification.

13.6.2.10.9. The creepage and flashover distances of the high voltage insulator shall be suitable for the outdoor service conditions, specified in the schedules.

13.6.2.10.10. The bidder in the offer is to state the suitable precautions/methods, adopted during design stage of the CVT to avoid the un-desirable effects due to ferro resonance phenomena.

13.6.2.10.11. It should be stated in the bid offer regarding the steps taken in the design stage for elimination/minimization of the influence of the transient response on the behaviour of high-speed relays.

13.6.2.10.12. It shall be ensured by the bidder in the offer that the connection of carrier, frequency coupling device across the CVT will not affect the designated accuracy class of the CVT windings.

13.6.2.10.13. The capacitor divider unit shall comply to IS: 9348/1979.

13.6.2.10.14. It shall also be complied in the offer through a calculation sheet, proving that the designated accuracy class of the CVT (both metering and protection) are not affected by extreme temperatures, to be encountered in service conditions (Max. ambient temperature 50º C and minimum -0º C).The terminal connectors should be suitable for 'ACSR' Conductor as per site requirement.

11.7. TESTS:

13.7.1 Type Tests:

The offered 33 KV& 132KV Inductive voltage transformer 400kV, 220kv, 132KV capacitive voltage transformer should have been subjected to the following type tests in a Government approved Test Laboratory. The bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and to the design/type offered against this specification, the purchaser reserves the right to demand repetition of some or all type tests/special tests without any extra cost to AEGCL in the presence of purchaser's representative at the cost of the supplier.

For 33 KV, 132 KV IVT:

(a) Temperature rise test.

(b) Lightning Impulse Test.

(c) High Voltage power frequency wet withstand voltage tests.

(d) Determination of errors.

(e) IP-55 Test on secondary Terminal Box.

(f) RIV Test

(g) Creepage distance measurement test

N.B.: (i) The dielectric type tests should have been carried out on the **Same design and type of IVT.**

(ii) After the IVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.

(iii) For Temperature Rise Test, the test must have been made with the appropriate rated burden, connected to each secondary winding.

For 400kV, 220kV & 132kV CVT.

Type Tests/Special Tests for 400kV, 220kV, 132kV CVT:

a) Lightning Impulse voltage test on complete CVT unit.

b) Power frequency over-voltage test on complete CVT unit.

c) Partial discharge test.

d) Radio interference voltage test.

e) Corona extinction voltage test.

f) Temperature rise test on complete CVT unit.

g) Ferro resonance test on the complete C.V.T. unit.

h) Transient response tests.

i) Determination of Temperature Co-efficient test.

j) High frequency capacitance and equivalent resistance measurement test (as per IEC-358)

k) Stray capacitance and stray conductance test (as per IEC-358).

l) Accuracy tests.

m) Thermal stability test.

n) Thermal Co-efficient test (as per IEC-358)

o) Fast transient test.

p) Seismic withstand test.

q) IP-55 test on secondary Terminal Box.

r) Magnetization and internal burden tests.

s) Effectiveness of sealing tests.

t) Mechanical Terminal load test on Bushing.

u) Dielectric loss angle test (Tan Delta Test).

v) Switching impulse withstand test

w) Critical impulse withstand voltage of insulator housing.

N.B: 1. The dielectric type tests should have been carried out on the same CVT.

2. After the CVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.

3. The ratio errors, phase displacements before, during and after the temperature rise test on complete CVT unit should have been determined with stipulated burdens and the same should comply with the designated accuracy class for each winding of the CVT.

13.7.2 Routine Tests:

The following routine tests shall be conducted on each IVT in the presence of Purchaser's representative for which no charges will be payable by AEGCL. No sampling is allowed. (a) Verification of terminal markings.

(b) Power frequency withstand tests on primary windings/capacitor voltage divider for CVT

(c) Partial discharge measurement for 400kV, 220kV & 132kV CVT.

(d) Power frequency withstand tests on secondary windings/Low voltage terminal of the capacitor divider for 400kV, 220kV & 132kV CVT.

(e) Determination of errors on complete IVT/CVT.

(f) Measurement of Insulation resistance.

(g) Oil leakage test.

(h) Measurement of capacitance and dielectric dissipation factor before and after dielectric tests (as per IEC-358)

(j) Power frequency tests on electromagnetic unit for 400kV, 220kV & 132kV CVT.

(j) Any other test as per relevant national & international standards.

(k) Creepage distance measurement test.

N.B.: Determination of errors shall be performed after the other tests. The standard reference VT to be used during testing for determination of ratio error and phase angle error should of 0.05 accuracy class or better as per standard practice, presently adopted by AEGCL.

11.8. INSPECTION:

11.8.1. The Purchaser shall have access at all times to the works and all other places of manufacture, where the IVTs/CVTs are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacturer of all the accessories and for conducting the necessary tests.

11.8.2. The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection at the discretion of the Purchaser.

11.8.3. No material shall be dispatched from its manufacture unless the material has been satisfactorily inspected, tested and dispatch clearance issued. However, the Purchaser reserves the right to alter the despatch schedule attached to this Specification.

11.8.4. The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this Specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

11.8.5. Clear 15 (Fifteen) days' notice shall be given to this office for deputing officer(s) for inspection. The Voltage Transformers shall be despatched only after the inspection is conducted by a representative of AEGCL and release order, issued from this office after approval of Routine Test Certificates. The shop routine test certificates in triplicate for all the Voltage Transformers along with the calibration certificates of all the meters and equipments to be used during testing (as per Annexure-B of the Specification) should be furnished along with the Inspection Offer. The Inspecting Officer will be authorised for inspection of the Voltage Transformers subject to the condition that the routine test certificates and calibration certificates of the testing equipments/meters will be found to be in order.

11.9. QUALITY ASSURANCE PLAN:

11.9.1. The Bidder shall invariably furnish following informations along with his offer.

(i) Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards, according to which the raw materials are tested, list of tests, normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.

(ii) Information and copies of test certificates as in (i) above in respect of bought out items.

(iii) List of manufacturing facilities available.

(iv) Level of automation achieved and list of areas where manual processing exists.

(v) List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspection.

(vi) Special features provided in the equipment to make it maintenance free.

(vii) List of testing equipments, meters and test plant limitation, if any, vis-à-vis the type, acceptance and routine tests, specified in the relevant standards. These limitations shall be very clearly brought out in the offer.

(viii) All the testing equipments, meters etc. should have been calibrated in a Government approved laboratory. The Bidder must submit the list of testing equipments and meters test as per the Technical Specification.

(ix) QAP shall include acceptance criteria against all parameters with relevant clause of standards

11.9.2. The Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

(i) List of raw materials as well as bought out accessories and the names of the materials as well as bought out accessories and the name of Sub-suppliers selected from those, furnished along with the offer.

(ii) Type test certificates of the raw materials and bought out accessories.

(iii) Quality Assurance Plan (QAP) with hold points for the Purchaser's possible inspection. The QAP and hold points shall be discussed between the Purchaser and the Supplier before the QAP if finalised.

13.9.3. The Supplier shall submit the routine test certificates of bought out items and raw materials at the time of acceptance testing of the fully assembled equipment.

11.10. DOCUMENT:

The supplier shall furnish four sets of following drawings/documents along with his offer.

(a) General outline and assembly drawings of the Inductive Voltage Transformers/ Capacitive

Voltage

Transformers. (b)

Sectional views

showing:

i) General constructional features.

ii) Materials/gaskets/sealing used.

iii) The insulation of the winding arrangements, method of connection of primary/ secondary winding to the primary/secondary terminals etc.

(c) Schematic drawing.
(d) Rating & diagram plate as per relevant

IEC/ISS (e) Secondary Terminal Box.

(f) Assembly Sectional view of Primary terminal/capacitor voltage

divider (g)Assembly drawing for secondary terminal

(h) The detailed dimensional drawing of Porcelain Housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.

(i) Sectional view of pressure release device.

(j) Drawing showing details of Oil level.

(k) All type test reports relating to the tests as specified in Clause-8.1 of the above.

(l) Ratio and phase angle error curves for IVTS/ CVTS

(m) Magnetization characteristic curves such as B-H curves and Sp. Loss vs. Flux density curves for core material, used for IVT & EMU unit of CVT.

(n) Sectional view of EMU unit of 220KV&132KV CVT.

(o) Schematic diagram showing the working of CVT in PLCC.

11.11. TEST REPORTS:

(i) Four copies of type test/special test reports shall be furnished to the Purchaser with the tender offer.

(ii) Copies of acceptance test reports and routine test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be despatched.

(iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Purchaser.

(iv) All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.

(v) The necessary galvanized flanges, bolts etc. for the base of the Inductive/Capacitive Voltage Transformers shall be supplied without any extra cost to the purchaser.

13.12 APPENDIX I.

TECHNICAL REQUIREMENTS FOR 33kV, 132kV & 220kV INDUCTIVE VOLTAGE TRANSFORMERS & 132kV, 220kV, 400kV CAPACITIVE VOLTAGE TRANSFORMER.

Sl. No	Particulars	33kV IVT	132kV IVT	132kV CVT	400kV/220kV CVT
I	II	III	IV	V	VI
1	Type	Single phase, 50Hz, oil filled, self-cooled, Hermetically sealed, outdoor porcelain type.	Single phase, 50Hz, oil filled, self-cooled, Hermetically sealed, outdoor porcelain type.	Single phase, 50Hz, oil Filled, self-cooled, Hermetically sealed, Outdoor porcelain type.	Single phase, 50Hz, oil Filled, self-cooled, Hermetically sealed, Outdoor porcelain type.

2	Nominal system voltage.	33kV	132kV	132kV	400 kV/220kV
3	Highest system voltage.	36kV	145kV.	145kV	420kV/245kV
4	Frequency.	50Hz± 5%	50Hz± 5%	50Hz ± 5%	50Hz± 5%
5	System	Effectively	Effectively	Effectively	Effectively solidly earthed.
	earthing.	solidly earthed	solidly earthed	solidly earthed.	
6	Number of phases.	3 [single phase]	3 [single phase]	3 [single phase]	3 [single phase]
7	(i) Number of secondary windings. (ii) Purpose of windings.	3 [three] Protection & metering.	3 [three] Protection & metering.	3 [three] Protection & metering.	3 [three] Protection & metering.
8	Rated primary voltage.	33/1.732kV	132/1.732kV	132/1.732kV	400/1.732 kV 220/1.732 kV
9	Rated secondary voltage.	Winding-II &III- 110/1.732V (Protection) Winding-I- 110/1.732V (Metering)	Winding-II &III- 110/1.732V (Protection) Winding-I- 110/1.732V (Metering)	Winding-I- 110/1.732V Winding-II- 110/1.732V Winding-III- 110/1.732V	Winding-I- 110/1.732V Winding-II- 110/1.732V Winding-III- 110/1.732V
10	Ratio	33kV/1.732: 110V/1.732 110V/1.732	132kV/1.732: 110V/1.732 110V/1.732	132kV/1.732: 110V/1.732 110V/1.732	400kV/1.732: 110V/1.732, 110V/1.732 220kV/1.732: 110V/1.732 110V/1.732
11	Rated burden.	Winding-I(M)- 50VA Winding-II(P)- 50VA Winding-III(P)- 50VA	Winding-I(M)- 50VA Winding-II(P)- 50VA Winding-III(P)- 50VA	Winding-I (M)- 30VA Winding-II (P)- 30VA Winding-III(P)- 30VA	Winding-I (M)-30VA Winding-II (P)-30VA Winding-III(P)30VA
12	Accuracy class	0.2/3P/3P	0.2/3P/3P	0.2/3P/3P	0.2/3P/3P
13	Rated voltage factor at rated frequency.	1.2 continuous. 1.5 for 30second.	1.2 continuous. 1.5 for 30second.	1.2 continuous. 1.5 for 30second.	1.2 continuous. 1.5 for 30second.
14	Temperature rise at 1.2 times the rated primary voltage, rated frequency & rated burdens.	As per IEC- 186.	As per IEC-186.	As per IEC-186/61869	As per IEC-186/61869

15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency & rated burden.	As per IEC- 186.	As per IEC-186.	As per IEC-186/61869	As per IEC-186/61869
16	One-minute power frequency dry/wet withstands test voltage for primary winding.	70kV[rms]	275kV[rms]	275kV[rms]	650kV[rms](400kV)/ 460kV[rms](220kV)
17					
18	1.2/50 micro second impulse withstand test voltage for primary winding	170kV[peak]	650kV[peak]	650kV[peak]	1425kV[peak] (400kV)/ 1050kV[peak] (220kV)
19 (i) (ii)	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal	3kV[rms] -	3kV[rms] -	3kV[rms] 10kV[rms] for exposed terminals & 4kV[rms] for terminals, enclosed in a weatherproof box.	3kV[rms] 10kV[rms] for exposed terminals & 4kV[rms] for terminals, enclosed in a weatherproof box.
20	Class of insulation.	B	B	B	B
21	Material of the conductor of primary and secondary windings.	Copper.	Copper.	Copper for EMU	Copper for EMU
22	Fault level	31.5kA [rms] for 3 second.	40 kA [rms] for 3 second.	40 kA [rms] for 3 second.	50KA for 3 (220kV) / 63KA(400kV)[rms] for 3 second.

23	Minimum creepage distance.	1116mm	4495mm	4495 mm	13020(400kV)/7595(220kV) mm
24	Quality of oil.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS- 335.	EHV Grade As per IS-335.
25	Radio interference voltage at 1.1 times maximum rated voltage at 1.0 MHZ.	-	500 micro volts.	500 micro volts.	500 micro volts.
26	Partial discharge level.	-	Less than 10 piccocoulombs.	Less than 10 Piccocoulombs.	Less than 10 piccocoulombs.
27	Seismic acceleration Horizontal – Vertical –	0.5g. 0.6g.	0.5g. 0.6g.	0.5g. 0.6g.	0.5g. 0.6g.
28	Accuracy class of standard V.T. to be used	0.05 or better.	0.05 or better.	0.05 or better.	0.05 or better.
	during testing towards determination of ratio errors and phase angle errors for metering windings.				
29.	Capacitance (Pf)	-	-	4400 + 10%, -5%	4400 (for 220kV), 8800 (for 400kV) + 10%, -5%

Note:

(i) For Station service bay equipments rated system voltage shall be 33kV and highest system voltage shall be 72.5kV.

SECTION-12: TECHNICAL SPECIFICATION OF BATTERY BANK AND CHARGER

12.1.0. SCOPE

12.1.1. This Section of the Specification covers the design, manufacture, and testing at manufacturer's work, of stationary type sealed, Valve Regulated Lead Acid Battery Bank, Dual FCBC Battery Charger, DC Distribution Boards and LTAC Panels complete with all required accessories for various Sub-stations.

12.2.0. BATTERY BANK

12.2.1. TYPE AND RATING

A. **For Substation with highest voltage of 145 kV (if not specifically mentioned in the Schedule of Quantities)**

For 220 KV, 132 KV & 66 KV sub-stations, DC System shall consist of One (1) float cum-boost charger and one (1) battery set for 220V system. DC scheme shall consist of one (1) battery.

i) Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 110 Volts D.C. system to meet loads like emergency lightning, control and signaling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 60896.

ii) The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 300 AH.

iii) The nominal voltage of the battery bank shall be 110 Volts D.C.

iv) The number of cells in a complete battery bank set shall be 55 plus 2 spares.

B. **For Substation with highest voltage of 245 kV (if not specifically mentioned in the Schedule of Quantities)**

(i). Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 220 Volts D.C. system to meet loads like emergency lightning, control and signaling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 60896.

(ii). The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 300 AH.

(iii). The nominal voltage of the battery bank shall be 220 Volts D.C.

(iv). The number of cells in a complete battery bank set shall be 110 plus 2 spares.

C. <u>48V Battery Bank</u>

i) Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 48 Volts D.C. system to meet loads like emergency lightning, control and signalling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 896, Part 2 / ANSI T1.330.

ii) The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 150 AH.

iii) The nominal voltage of the battery bank shall be 48 Volts D.C.

iv) The number of cells in a complete battery bank set shall be 24 plus 2 spares.

12.2.2. PLATES

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free, long life both in cyclic as well as in, float applications. Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life, durability and trouble-free operation of battery. PLC operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of paste preparation is not allowed.

12.2.3. CONTAINER AND LID

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable lo deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability.

12.2.4. VENT PLUGS

Each cell shall be equipped with one-way safety valve with opening pressure of 5±1 psi and closing pressure 4±1 psi. The vent plug shall be made with suitable grade of fire-retardant plastic material. Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

12.2.5. SEPARATORS

Separator shall be made of spun glass, micro porous matrix and shall be resistant to Sulphuric Acid. It shall be capable of keeping the entire electrolyte and shall be electrically insulated. Sufficient separator overlap and PVC shield protection to top and bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates.

12.2.6. CONNECTORS

The connectors shall be lead coated copper of suitable size to join the cells. The connectors shall be suitably designed and coated to withstand corrosion due to sulphuric acid. The coating should be adequate and tenacious. All the copper inter cell connectors shall be provided with heal shrinkable sleeves except at the connecting points.

12.2.7. ELECTROLYTE:

The electrolyte shall be prepared from the battery grade Sulphuric Acid confirming to ISS: 266. The batteries shall be supplied in factory filled and charged condition.

12.2.8. WATER

Water required for preparation of electrolyte shall conform to IS: I069.

12.2.9. PLATE CONNECTION

Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be caste with lead alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

12.2.10. BOLTS AND NUTS

Nuts and Bolts for connecting the cells shall be of superior grade passivated Stainless steel.

12.2.11. TERMINALS

Terminals shall be of integral lead terminal with solid copper core with M6 threading for fastening. The junction between terminal posts and cover and between the cover and container shall be hermetically sealed.

12.2.12. BATTERY RACKS

Batteries shall be installed on MS racks to be supplied by the Contractor to fit in the battery room. Racks/Trays shall be powder coated with anti-corrosive paint. Rack shall accommodate 55/110 cells plus 2 spares. Racks/Tray shall be suitably treated before painting for protection against fungus growth and other harmful effects due to tropical environment.

The colour of the supporting racks shall conform to shade 631 of IS: 5.

12.3.0. BATTERY CHARGING EQUIPMENTS

12.3.1. GENERAL DESCRIPTION

- The battery charging equipment shall have two separate Boost-cum Trickle Charger sections. Each section shall have its own rectifier transformer, rectifier bridge and other equipment so that each section can operate independent of each other. The charger-I shall normally be in float mode and will supply load while Charger-II remains as hot standby. In case charger in boost mode, the Charger-II shall supply the normal load.
- Each section of the battery chargers shall be capable of continuous operation at itsrated load in float charging mode, i.e., Float charging the associated Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate.
- Each charger section shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

12.3.2. OPERATION AND CONTROL

- During normal operation of the one of the charger sections shall supply the normal direct current requirements of the substation and the station battery shall be floating on the other charger section. In the event of failure of A.C. supply or failure of the both sections of the charger itself the battery shall come automatically across the load without any interruption. Similarly in case of failure of any one section of the charger the DC load or the battery as the case may be, shall come automatically change over to the healthy charger section without any interruption.
- All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float

charging, the Charger output voltage shall remain within +1% of the set value, for AC input voltage variation of +10%, frequency variation of +5%, a combined voltage and frequency variation of +10%, and a DC load variation from zero to full load. All battery chargers shall have a constant voltage characteristic throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

- All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load limiter setting shall also be possible from 80% to 100% of the rated output current for charging mode. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service).
- It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

12.3.3. MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables for two charger sections. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation. Rectifier Transformer. The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

12.3.5. Rectifier Assembly

The rectifier assembly shall be fully/half-controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

12.3.6. Instruments

One AC voltmeter and one AC ammeter along with selector switches shall be provided for each charger sections. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Charger sections. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a center zero voltmeter with selector switch shall also be provided for each charger sections for testing purpose.

12.3.7. Air Break Switches

One DC output switch shall be provided in each charger sections. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. `ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

12.3.8. Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

12.3.9. Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

12.3.10. Annunciation System

Audio-visual indications through bright LEDs shall be provided in each Charger sections for the following abnormalities:

a) AC power failure
b) Rectifier/chargers fuse blown.
c) Over voltage across the battery when boost charging.
d) Abnormal voltage (High/Low)
e) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Employer's Control System. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

12.3.11. Charger Construction

- The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalized and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed.
- The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part I. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

12.3.12. Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be `Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) of IS:5 shall be applied, unless required otherwise by the Employer. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

12.3.13. CHARGER RATING

Each charger section shall have the following ratings:

A) For 220 Volt DC System

(i). Input Voltage : 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.
(ii). Output Voltage : 220 Volt (Nominal).
(iii). Output DC Current : 45 A

B) For 110 Volt DC System

(i). Input Voltage : 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.
(ii). Output Voltage : 110 Volt (Nominal).
(iii). Output DC Current : 45 A

C) For 48 Volt DC System
(i). Input Voltage : 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.
(ii). Output Voltage : 48 Volt (Nominal).
(iii). Output DC Current : 50 A

12.3.14. TESTS AND INSPECTION

The battery charger and all the components of the charger shall be routine tested accordingly to their relevant standard. This shall include the following:
(a) Operational check for boost cum float charger.
(b) Input / Output test of the chargers.
(c) Performance test of the charger.
(d) Temperature rise test of the rectifier transformer.
(e) Power frequency H.V. test / Insulation tests.

The Contractor shall be required to demonstrate to the employer that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out:
i) Insulation resistance test
ii) Checking of proper annunciation system operation.

The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the Employer:
(i) Switches.
(ii) Relays/MCCBs
(iii) Instruments.
(iv) DC fuses.
(v) SCR.
(vi) Diodes.
(vii) Condensers.
(viii) Potentiometers.
(ix) Semiconductor
(x) Annunciator.
(xi) Control wiring
(xii) Push button sand contactors
Makes of above equipment shall be subject to Employer's approval.

12.4.0. DC DISTRIBUTION BOARD

12.4.1. General Features

The D.C. distribution boards shall be indoor, floor mounting of self-supporting, sheet metal clad, and cubicle type. The panels should be totally enclosed, dust tight and vermin proof and shall be made of 2.0 mm cold rolled sheet steel. The boards shall be provided with double leaf hinged doors at the back. All doors and covers shall be fitted with rubber gaskets. The doors shall be provided with locks and duplicated covers.

12.4.2. Bus bars

The bus bars shall be of electrolytic copper of ample cross-section. The bus bars shall be insulated from the structure by means of durable, non-hydroscopic, noncombustible and non-tracking materials.

12.4.3. Detail Requirements

The 110/220 Volts D.C. distribution boards shall be provided with the following:
i. One mains failure alarm relay.
ii. One earth fault alarm relay.
iii. One 110/220 Volts D.C. bell to be operated by the mains failure alarm relay.
iv. One 110/220 Volts D.C. buzzer to be operated by the earth failure alarm relay.
v. One double pole air-break circuit breaker of 400 amp capacity with thermal overload tripping arrangement to act as incoming breaker of the load bus.
vi. One 0-150/300 volts D.C. moving coil voltmeter to measure the bus-bar voltage. The display is to be in digital.
vii. One pilot lamp to indicate D.C. on conditions.

viii. 250 volts, double pole MCBs of following ratings for outgoing feeders.
a. 16 Amp, 6 Nos.(8 Nos. for 220 V system)
b. 32 Amp, 6 Nos. (8 Nos. for 220 V system).
c. 63 Amp, 2 Nos
ix. One terminal Board/block for all feeder outlets including cable glands.

12.4.4 4 DC Distribution Board will have 2 sections, each section will be fed from independent Battery charger. Busbar rating 150 A for 48 V DC, 16 kA / for 1 SEC, AL or Copper, IP 54 , 2 mm COLD ROLLED / 3 mm HOT ROLLED

12.5.0. LTAC PANEL

12.5.1. General Arrangement

The 415 volts L.T.A.C. panels shall be indoor floor mountings sheet metal clad type comprising of MCCBs and MCBs and bulbar chambers and equipped with circuits and equipment as specified. The different circuits shall be mounted above and below the bus bar chamber to form a suitable arrangement, except that the incomings will be located at the front and mounted below the bus bar chamber. All equipment shall be suitable for the reception of the cables rising from the ground level. The switchboards shall be so designed as to be readily extensible.

12.5.2. Bus bars

The phase and neutral bus bars shall be of high conductivity Aluminium of adequate uniform cross section. The bus bars shall be insulated from the structure by means of durable non-hygroscopic, non-combustible and non- tracking materials. Bulbar joints shall be of bolted type.

12.5.3. Detail Requirements

The 415 Volts, L.T.A.C. Switchgears shall have two Bus Sections with following circuits and equipment:
a) INCOMING: Two numbers each fitted with following (for each Bus Section):
i. 630 Amp, Electrically operated, TPN MCCB and cable glands suitable for 4-core P.V.C. cable labelled as 'INCOMING'.
ii. One Voltmeter with VSS.
iii. One Ammeter with ASS.
iv. One K.W.H. meter with connected C.T.

b) BUS COUPLER: One number fitted with following:
i. 630 Amp, TPN MCCB and cable glands suitable for 4-core P.V.C. cable labelled as 'INCOMING'.
ii. One Ammeter with ASS.

c) OUTGOINGS: Each Bus Section shall have following numbers of MCCBs for outgoing feeders:
i. One number 200 Amps T.P.N. MCCB.
ii. Two number 100 Amps TPN MCCB.
iii. Two numbers 63 Amps TPN MCCB.
iv. Two numbers 32 Amps TPN MCCB.
v. Three numbers 32 Amps SPN MCB.

12.5.4. Automatic AC Source Changeover

Automatic changeover between Incomer I and Incomer II is to be carried out during the failure of supply in any one of the incomers. After the restoration of the supply, system shall be restored to normal condition automatically. The requirement of changeover under various conditions are as below:
a) Under normal conditions i.e. when supply is available in both the incomers, incomers I & II of 415 V LTAC Panel shall be in closed condition and Bus Couplers breaker shall be in open condition.
b) In case of failure of either of the sources, the incomer of that source shall trip and Bus Coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.
To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be initiated after a time delay, after the conditions warranting such change has been detected.
Any devices required to achieve the requirements above shall deem to be included in the scope of works.

SECTION-13 TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS

13.1.0 SCOPE

13.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor, and accessories for Power Conductors.

13.2.0 POWER CONDUCTOR

13.2.1 TYPE OF CONDUCTOR

The ACSR Conductor shall generally conform to IEC: 61089/ IS: 398 (relevant part)/ ASTM:B-232 except where otherwise specified herein. Conductor conforming to a standard other than the Indian Standard specification then an English version of the Standard in addition to the original standard if written in a language other than English should be submitted indicating clearly the advantage, if any, that would be obtained by the Employer for adopting this standard instead of the said India Standard.

13.3.0 STANDARD TECHNICAL PARTICULARS

All ACSR Conductor shall satisfy all the parameters as furnished in Technical Data Sheet. All the aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

The steel strands shall be hot dip galvanised and shall have a minimum zinc coating.

13.4.0 MATERIAL

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IEC: 60889.

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

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

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

13.5.0 JOINTS IN WIRE

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

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

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

13.6.0 STRANDING

The wires used in construction of a ACSR conductor shall, before and after stranding, satisfy all requirements of IS 398 with latest amendments thereof.

The lay ratio of the different layers shall be within the limits as per the said Standard. In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right-handed. The wires in each layer shall be evenly and closely stranded. In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

13.7.0 TYPE/ROUTINE/ACCEPTANCE TESTS

Type Test:

The following tests shall be conducted on a sample/sample of the conductor(s) required under the package from each stranding machine from which the conductor is to be manufactured & supplied:

a) DC resistance test on stranded conductor
b) UTS test on stranded conductor
c) Corona extinction voltage test (dry)
d) Radio interference voltage test (dry)

Acceptance Test:

a) Visual and dimensional check on drum
b) Visual check for joints, scratches etc. and length measurement of conductor by rewinding
c) Measurement of diameters of individual Steel and Aluminium strands
d) Galvanizing test on steel strands
e) Check for lay Ratios of various layers
f) Torsion and Elongation tests on steel strands
g) Breaking load test on steel and Aluminium strands
h) Wrap test on Steel & Aluminium strands
i) DC resistance test on Aluminium strands
j) Procedure qualification test on welded joint of Aluminium strands
k) Drum strength test (steel drum)
l) Barrel Batten strength test (wooden drum)

The above acceptance tests shall be repeated on one conductor sample taken from site in presence of AEGCL's representative for each 500km progressive supply. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by AEGCL's site representative and the tests shall be witnessed by AEGCL's representative.

Routine Tests:

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

Tests During manufacture:

a) Chemical Analysis of Zinc used for galvanising
b) Chemical Analysis of Aluminium used for making Aluminium Strands
c) Chemical Analysis of Steel used for making Steel Strands.

13.8.0 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

13.9.0 PACKING

All conductor reels shall conform to latest edition of IS: 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable, that is next to the lagging.

The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

The wooden drums shall preferably be given protective coating of a reliable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.

13.10.0 TECHINCAL DATA SHEET FOR CONDUCTOR

ACSR Panther

Sl. No.	DESCRIPTION	ACSR 'PANTHER'
1	Code name	PANTHER
2	Number of strands & size	Al: 30/ 3.00 mm St: 7/ 3.00 mm
3	Overall diameter	21.00 mm
4	Breaking load	130.32 kN
5	Weight of conductor	974 kg / km
6	Co-efficient of linear expansion	19.35×10^{-6} /^{0}C
7	Number of strands	
	Steel centre	1
	1st Steel Layer	6
	1st Aluminium Layer	12
	2nd Aluminium Layer	18
	3rd Aluminium Layer	-
8	Sectional area of Aluminium	212.10 mm^2
9	Total sectional area	261.50 mm^2
10	Calculated d.c. resistance at 20^0 C	0.1400 ohm/km
11	Ultimate tensile strength	89.67

CHAPTER 14: GIS EQUIPMENTS

14.1 GENERAL

The GIS manufacturer shall design, manufacture, test, deliver at site, **commission** and guarantee the GIS components and services as defined in this Technical Specification.. The complete GIS based on the Single Line Diagram shall be provided for connection to Power Transformers/Reactors/Lines feeders with associated circuit breaker, disconnect switch and grounding switch (maintenance and high speed), instrument transformers, and surge arrestor (if applicable) etc.

14.2 GENERAL CHARACTERISTICS

14.2.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of it's constituent parts. It should be designed for indoor application with meteorological conditions as specified.

14.2.2 All parts of the bus bar, switchgear and the bus ducts (for both indoor and outdoor applications) shall be as mentioned below:

400 kV GIS	Single phase enclosed
220kV GIS	Single Phase/Three Phase enclosed
132 KV GIS	Three Phase enclosed

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14.2.3 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall deemed to be included.

14.3 REFERENCE STANDARDS

The GIS offered shall confirm to IEC 62271-203 and other relevant IEC standard except to the extent explicitly modified in the specification and shall be in accordance with requirement specified in general design criteria The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening:

IEC 62271-1	: High-voltage switchgear and control gear Part 1: Common specifications
IEC 62271-203	: High-voltage switchgear and control gear Part 203: Gas- insulated metal-enclosed switchgear for rated voltages above 52 kV Circuit-breakers:
IEC 62271-100	: High-voltage switchgear and control gear Part 100: Alternating- current circuit breakers
IEC 62271-101	: High-voltage switchgear and control gear Part 101: Synthetic testing Disconnectors, earthin switches.
IEC 62271-102	: High-voltage switchgear and control gear Part 102: Alternating- current dis-connectors and earthing switches Instrument transformers:
IEC 62271-303	: High-voltage switchgear and control gear – Use and handling of sulphur hexafluoride (SF_6)
IEC 61000	: Electromagnetic compatibility (EMC)
IEC 60060	: High voltage test techniques
IEC 60071	: Insulation co-ordination
IEC 60255	: Electrical relays
IEC 60265	: High voltage switches
IEC 60270	: High-voltage test techniques - Partial discharge measurements
IEC 60376	: Specification and acceptance of new sulphur hexafluoride
IEC 60480	: Guide to checking of sulphur hexafluoride (SF_6)
IEC 60529	: Degrees of protection provided by enclosures (IP Code)
IEC 60815	: Guide for the selection of insulators in respect of polluted conditions
IEC 61869/60044/60185/60186/60044-6:	: Instrument transformers
IEC 60364 / 60479 / 60621 / IEEE std. 80/CIGRE 44	: Standards for station grounding
CENELEC/SVDB/**ASME**:	Boiler & Pressure vessel code
IEC 693	: Seismic Design
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated switchgear
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEEE 80 2013	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide.
IEC 62271-211	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

Cable Connections:

IEC 62271-209: High-voltage switchgear and control gear Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and dry- type cable-terminations

Outdoor Bushings:

IEC 60137: Insulated Bushings For Alternating Voltages Above 1000 V Transformer Direct Connection:

Iec 61639: Direct Connection Between Power Transformers And Gas-Insulated Metal-Enclosed Switchgear For Rated Voltages Of 72.5 Kv And Above.

Surge Arresters:

Iec 60099-4: Surge Arresters Part 4: Metal-Oxide Surge Arreste rs Without Gaps For A.C. Systems SF_6-Gas:

IEC 60480: Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use

IEC/TR 62271-303: High-voltage switchgear and control gear Part 303: Use and handling Of sulphur hexafluoride (SF6) Local Control Cubicles:

IEC 61439 -1: Low-voltage switchgear and control gear assemblies Part 1: General rules EMC. IEC 62271-1: High-voltage switchgear and control gear Part 1: Common specifications

IEC 60267 Out of phase switching of Circuit Breaker

IEC 60129 Inductive current breaking

IEC 61128: Bus transfer capability of disconnecting switch

IEC 60859: Cable termination design

The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer and the manufacturer shall list all such applicable standards, codes etc. The manufacturer shall supply those standards (soft copy) as and when required by AEGCL without any extra cost borne to AEGCL.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

Modular Design

Housings and expansion joints together form the pressure-resistant enclosure of the switchgear. The housings are made of cast aluminium alloy **or high-grade steel of adequate thickness to withstand internal arc test (burn through test) for minimum 300ms**,the expansion joints of high-grade steel and the covers of steel or aluminium.

The manufacturing and testing of the housings are state-of-the-art technology. Each, housing is subject to a pressure and gas tightness test and complies with the requirements of the relevant CENELEC standard.

Surface Treatment Steel (covers):

Indoor structure: Hot galvanised or painted Outdoor structure: Hot galvanised and painted High-Grade Steel (expansion joints):

Indoor Pre-treatment: none Paint work: none

Outdoor Pre-treatment: degrease

Paint work: same as housings of cast aluminium

Cast-Aluminium:

Pre-treatment (indoor and outdoor): Sand-blast or degrease alkaline

Internal surfaces (cast-aluminium): As per manufacturers type tested design Internal surfaces (aluminium wrought alloy): without surface treatment

External surfaces material description: high-resistant 2-component **epoxy paint:**

As per manufacturers type tested design Gas, Gas compartments, monitoring of gas compartments:

SF6 serves as insulation for the enclosure of several separately-sealed gas compartments

Static filters in all gas compartments – with single-phase encapsulation for each phase for single phase encapsulation design - absorb moisture and decomposition products; the filter material is placed in filter bags which are supplied in airtight cans all gas compartments are equipped with rupture diaphragms and, if necessary, with gas diverter nozzles; these nozzles are arranged in a way that, if the rupture diaphragm bursts, the gas flow is guided away in a direction not unnecessary hazardous to either personnel or equipment the modules of circuit-breakers, voltage transformers, cable connection module and surge arresters form separate gas compartments. The disconnector gas compartment can contain other device like earthing switch the switch operating shafts are supported and provided with lip seals against pressure and vacuum loss in such a way that during the evacuation process before commissioning no air can penetrate and no SF6 can escape during operation; the leakage rate is less than 0.5 % SF6 per year and gas compartment.

The gas pressure is monitored by density monitors with indication; density monitors are installed directly at the gas compartment they monitor.

14.4 GENERAL DESIGN AND SAFETY REQUIREMENT

14.4.1 The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw material, manufacturing process etc. so that the GIS provides longlife with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

14.4.2 The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

14.4.3 The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

14.4.4 All circuit breakers, disconnect switches and other component of GIS having identical rating shall have identical and interchangeable parts and operating mechanism as far as possible.

14.4.5 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Further, it is prohibited to work adjacent to a gas compartment while it is fully pressurized on the other side. For such cases, the gas pressure in the adjacent compartments needs to be reduced.

14.4.6 Disconnector and Earth switch module shall not be combined with bus bar module in same gas zone. Cable termination module shall be in separate gas zone.

14.4.7 Expansion joints provided to be locked in place after alignment is complete considering calculated maximum thermal expansion for all plug-in contacts. Pressure relief device shall be provided in each gas partition module along with moisture adsorber located in a suitable place. 100 micro-meter or smaller sintered stainless-steel particle filtered disc shall be provided in gas filling port.

14.4.8 Conductive particle traps shall be placed at support insulators (free from all voids), non-tracking type with sufficient mechanical and electrical strength. Single or double mitered elbows shall be used with bus duct depending on mechanical stress.

14.4.9 Cable termination module with removable link shall be designed as per IEEE 1300 or IEC 60859. SF6 to air bushing module shall be provided with bursting disc (rupture disc) of adequate design. GIS to transformer connection module shall be provided with self-compensating bellow located just above the transformer end termination point.

The switchgear must be sectionalized, with gas tight barriers between sections or compartments. The sections shall be designed to minimize operational shut down when the gas pressure is reduced due to Leakage or for maintenance purposes. Also, to minimize the quantity of gas that has to be evacuated and recharged before and after maintaining any item of equipment.

Continuous bus lengths without gas segregation shall not be acceptable for any voltage level.

Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section.

The gas system proposed shall be submitted with the proposal. External fixtures shall be of non-corrosive material and be capped wherever required.

For the purpose of gas monitoring and maintenance, the GIS shall be provided with gas density monitoring device along with temperature compensated gas density switch having two stage contacts in each gas compartment. Pressure relief devices shall be used wherever required.

Support insulators shall be used to maintain the conductors and enclosure in proper relation.

Barrier insulators which are employed to isolate gas compartments as well as support insulators shall be manufactured from high quality epoxy resin, free of all voids and be designed to reduce the electrical stress on the insulators to a minimum. The support insulator shall have holes on both sides for proper flow of gas.

The mechanical strength must be sufficient to ensure the conductor’s space requirements and clearances when short circuit faults occur. In addition, the gas barrier insulators sealing to the conductors and the enclosure wall shall be

designed to withstand the maximum gas pressure differential under normal operating condition and maximum pressure differential with one of the adjacent enclosures at three times operating gas pressure and the other at atmospheric pressure for five minutes. Its safety factor shall be as per IEC. **The GIS module shall be suitable to operate continuously when the inside SF6 pressure is equivalent to outside SF6 pressure.**

Tests shall be carried out during the manufacturing of the switchgear to ensure that all insulators are free of partial discharge at a voltage which is at least 10% higher than the rated voltage.

Gas System

The GIS shall be furnished with sufficient sulphur hexa-fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. During commissioning, the dew point of SF6 gas shall be measured and documented. Maximum water content of SF6 -gas in GIS, within guarantee period:

CB ≤ 150 PPM (volume) Others ≤ 500 PPM (volume)

The Gas loss of the switchgear shall be in no case higher than 0.5% per year.

No copper tubing between the phase for equalizing the gas pressure will be accepted.

Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O-ring type. The material and method of sealing used shall be stated in the tender.

Gas filters / treatment

Each gas compartment shall be fitted with gas filters, driers or desiccants for the absorption of moisture and the gaseous products of switching. The filter shall be effective for the duration of time between major overhaul. It shall be possible to replace the active material of the filter without extensive dismantling. The absorbent shall be located in an easily accessible location. The tenderer shall indicate the detail and type of filters used in the various gas sections.

Gas Monitoring Devices

Temperature-compensated gas density monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and online monitoring (Display at SAS) of the density of the gas. The monitoring device shall have two alarm settings. These shall be set so that:

First stage: Advanced warning can be given that the gas density is approaching an unacceptably low level Second stage: The relevant GCB can be locked for tripping/ closing.

SF6 Gas Treatment

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. Normally closed valve shall be provided to facilitate filling and recharging. In all gas compartments permanent efficient filters and drying agent shall be at least effective for the duration of time between major overhauls. The filters shall be capable of absorbing the by-products of SF6 gas during interruption.

14.4.10 The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures. GIS should be suitably sub-divided into individual arc and gas-proof compartments preferably for:

1) Bus bars
2) Intermediate compartment
3) Circuit breakers
4) Feeder Disconnect Switch
5) Voltage Transformers
6) Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
7) Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor (ifapplicable)

14.4.11 SERVICE CONTINUITY REQUIREMENT:

The GIS equipment with the given bus switching arrangement is divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be de-gassed.
Working conditions, method statements and procedures are to be furnished by the GISmanufacturer in order to ensure equipment and operating personnel's safety and to achieve following Service continuity conditions to the extent possible:

16.4.11.1 For One & half breaker bus switching scheme during a fault in CB compartment, No bus bar and feeder is permitted out of service during maintenance and repair/replacement.

16.4.11.2 For Double Main bus switching scheme during a fault in CB compartment, No bus bar permitted out of service during maintenance and repair/replacement.

16.4.11.3 During a fault in GIS compartment other than CB compartment, maximum one bus bar and/or one feeder permitted out of service during maintenance and repair/replacement.

Repair

In case of any internal fault in the bus bar or bus bar dis - connector, circuit breaker, grounding switches etc., repair works must be possible with at least one busbar in service. In case of any type of fault in any section of the line bay, transformer bay or bus coupler bay modules, repair works must be possible.

Any failure shall be immediately signaled by the systems inherent self-supervision with clear description of the nature and the location of this failure. Generally, any failure shall have impact only on the direct related devices and the rest of the substation shall remain in normal operation.

Removal of Components

The GIS shall be designed so that any component of the GIS can be easily removed. As minimum flexibility in the layout arrangement, it shall be possible to remove the circuit breaker with both bus bar remaining in service and it shall be possible to remove the dis connector of the bus bars, with one bus bar remaining in service.

14.4.12 The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition. This shall be validated with Type Test.

14.4.13 Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the

14.4.14 equipment. Inspection windows (View Ports) shall be provided for Disconnect Switch and both type of earth switches i.e. Maintenance and fast operating. **Stroboscopic port shall also be provided.**

14.4.15 The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators. Field welding of the conductor is not acceptable.

14.4.16 Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

14.4.17 The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning.

14.4.18 Each gas-filled compartment shall be equipped with static filters, density switches, filling valve, rupture discs and safety diaphragm. The filters shall be capable of absorbing any water vapor which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

14.4.19 The switchgear when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions, shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external/internal reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

14.4.20 The thermal rating of all current carrying parts shall be minimum for three sec. for the rated symmetrical short-circuit current.

14.4.21 The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

14.4.22 The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and employer.

14.4.23 The arrangement of the equipment offered must provide adequate access for operation, testing, Repair and maintenance.

14.4.24 All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighbouring bays and LCC panels. **To access the PT module suitable ladder shall be provided as necessary with grounding provision.**

14.4.25 It should not be possible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.

14.4.26 In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

14.4.27 The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation for 220 kV and above. **The maximum value of VFT shall be controlled so that there will be no damage to SF6 to air bushing, cable termination, insulating barriers used across the flange joints of the GIS and all the other components of GIS.**

14.4.28 The enclosure shall be of continuous design and shall meet the requirement as specified in of IEEE 80 2013 (special considerations for GIS).

14.4.29 The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

14.4.30 The fabricated metal enclosure shall be of Aluminium alloy/high grade steel having high resistance to corrosion, low electrical losses and negligible magnetic losses.

14.4.31 . The manufacturer shall clearly indicate the material used for different GIS enclosures in the GTP/design document during approval. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall confirm to metric system."The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

14.4.32 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro Tesla on the surface of the enclosure.

14.4.33 The switchgear shall have provision for connection with ground mat risers through copper connections. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

14.4.34 For 220 kV and above voltage class GIS, wherever required, stairs, fixed ladder, platforms, and walkways for operation and maintenance access to the operating mechanism and monitoring devices should be provided to permit access. The structures shall be hot-dipped galvanized steel. All structures, stairs, platforms, and walkways shall conform to the relevant occupational health and safety regulations and designed in accordance with the latest industry

standards and guidelines. The platforms and walkways shall have anti-skid surfaces that can be walked on. Handrails shall be provided where necessary. **The GIS supplier shall provide 3-D arrangement drawing to show the location of equipment and access to it.**

14.4.35 In addition to above suitable portable scissor lift shall be provided for access of distant portion of GIS installation.

14.4.36 New Gasket, sealant and desiccant shall be installed for permanent sealing of all site/field assembled joints. No gaskets are to be reused for any permanent seal broken or disturbed in the field/site.

14.4.37 The enclosure & support structure shall be designed such that person of 1780 mm in height and 90 Kg in weight is able to climb on the equipment for maintenance.

14.4.38 The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

14.4.39 Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

3.1 GAS INSULATING SYSTEM:

i) Loss of Gas Density
ii) Any other alarm necessary to indicate deterioration of the gas insulating system.

3.2 OPERATING SYSTEM:

i) Low operating pressure
ii) Loss of Heater power
iii) Loss of operating power
iv) Loss of control supply
v) Pole Discordance.

14.4.40 The equipment will be operated under the following ambient conditions (or as defined in thesection project):

a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, fordesign purposes, ambient temperature should be considered as 50 degree-C.
b) The humidity will be about 95% (indoors)
c) The elevation is less than 1000 meters

14.4.41 Temperature rise of all current carrying parts and enclosures shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions as specified.

14.4.42 All cabinet heaters shall be rated for 240V AC (1-phase) supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

Expansion Joints and Flexible Connection

Expansion and installation alignment shall be considered in the design of the bus and enclosure. The continuity of service during thermal expansion / contraction and vibrations shall be ensured. The switchgear shall be fixed to the floor with minimum requirement on floor preparation. If required, expansion joints shall be provided with compensator for the enclosure and sliding plug-in contacts for the conductors. Expansion joints and flexible connections shall be considered in the design of the bus

and enclosure to take care of thermal expansion / contraction and vibrations during service and to absorb the relative movement between the switchgear equipment and its fixing structure / floor. The position of expansion joints or flexible connections are to be considered by the manufacturer to ensure that the complete installation will not be subject to expansion stresses which could lead to distortion or failure of any piece of the SF6 equipment, support structures or foundations. These expansion joints shall be provided with each bay, which will provide maximum tolerance and the flexibility during the installation & maintenance.

Also, expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. Flexible joints may also be provided to allow more efficient maintenance and future extensions of the GIS.

14.4.43 **Bellows or Compensating Units:-** Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and for differential thermal expansion between the conductors and the enclosures. The bellows metallic(preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction maybe provided and shall be of following types:.

1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.
3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
5. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

14.4.44 **Indication and verification of switch positions**: Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches areopen or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

14.4.45 **Pressure relief device** : Pressure relief devices shall be provided in the gas sections to protect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Automatic external pressure relief devices shall be incorporated in the basic design as a precaution against bursting of enclosure. Internal pressure relief devices shall not be acceptable. The bursting pressure of the relief device shall be effectively coordinated with the rated gas pressure and the pressure rise due to arcing to avoid any mal-operation in normal operating conditions. Deflection devices shall be installed to ensure that personnel will not be endangered. Pressure relief shall be by means of a metallic bursting disc system with a preset opening pressure. For better gas tightness, bursting discs made of graphite or non-metallic material shall be avoided.

Pressure relief shall be achieved either by means of diaphragms or plugs venting directlyinto the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided.

14.4.46 **Pressure vessel requirements**: The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the Pressure Vessel Code (ASME/CENELEC code for pressure Vessel.)
The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.The metal enclosures for the GIS equipment modules shall be made from Aluminum alloy and tubular in construction. The tenderer shall state the material used for his particular design. All flanges shall be directly bolted together with good metallic contact to make enclosures equipotential.

Enclosures shall withstand normal and transient pressure in operation. They shall be designed and manufactured according to the related standards to safety and reliability of material, construction, welding technology and testing. Enclosures shall be designed to withstand any internal arc specified in IEC 62271-203.

The gas-filled enclosures shall comply to the pressure vessel code applied in the country of manufacturer and shall be suitable for purchaser's environmental condition.

14.4.47 GROUNDING:

16.4.43.1 The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

16.4.43.2 The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure, GIS surge arrestor etc. to the ground bus of GIS.

16.4.43.3 The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, current transformers, voltage transformers, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected either internally or externally with Copper bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of theGIS assembly & between those parts and the main grounding bus of the GIS.

16.4.43.4 Each marshalling box, local control panel, power and control cable sheaths and other non- current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

16.4.43.5 The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

16.4.43.6 All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS. The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents due to by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The manufacturer shall provide suitable barrier of non-linear resistor/counter discontinued SF6/Air termination SF6/HV cable bushing etc. to mitigate transient enclosure voltage.

a) Earthing of Main Circuits

To ensure safety during maintenance work all parts of the main circuit, to which access is required, shall be provided with facilities for connecting removable earthing device, after opening the enclosure, on the circuit element which is previously earthed via main earth switch.

b) Earthing of Enclosure

The enclosure shall be connected to earth. All metal parts other than main and auxiliary circuits shall be earthed. Separate earthing strips to short circuit flanges and earth switches are not allowed. Earthing switches shall be connected to earth through enclosures. Individual earth leads for the earth Switches are not recommended. The continuity of the earthing circuits shall be ensured taking into account thermal and electrical stresses caused by the current they have to carry. Each of the earthing strips shall be connected to the main earthing mesh installed below the GIS, at two ends.

c) Earthing of GIS

The earthing system shall be based on a multi-point design ensuring the protection in case of indirect contact (Touch or step voltages, in case of system fault) and transient phenomena in case of lightning or switching operations.

Earthing conductors shall allow fault with short circuit current for at least 3 sec. Separate ground strips to short circuit flanges and earthing switches are not allowed. Grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed.

Notes: EARTHING CONDUCTOR SHALL BE OF COPPER AND SIZE MAY VARY AS PER EARTHING CALCULATION AND THE SAME WILL BE DECIDED DURING DETAILED ENGINEERING. The GIS manufacturer shall furnish earthing design calculations with touch voltage limited to 65V.
Corrosion factor shall be taken into consideration while performing earthing design calculations.

Equipotential Earthmat: (below the GIS)

When a fault current flows through the earthing connections into the soil, the enclosures, linked to the earthing circuits, are carried at the same potential as the earthing mat conductors but this potential is generally different from that on the soil surface.

In order to ensure the security of personnel, it is necessary to install an equipotential mat linked to the general earthing mat in the zones where metal enclosures and fixed accessories are accessible from the floor.

It is also necessary to provide an equipotential earthing mat in the zones where an emergency mechanical operation or a locking system is accessible from the floor. It is therefore possible to extend the equipotential mat to allow the operator to carry out his manoeuvres.

In order to ensure a good equipotential surface, each element of the equipotential mat must be connected to the general earthing network by the manufacturer.

This mat will be placed on the floor, all around the switch gears. It is not required in front of the control cubicles. If it is an oxidizing material, it should be hot dip galvanized.

The manufacturer must provide and specify this equipotential earthing mat. The location of the equipotential mat should be defined by the supplier for all the GIS and at places where:

-the enclosures are accessible for the floor.

-Manual operation of apparatus or locking system is located.

Five copies of equipotential earth mat drawings along with design calculations may be submitted for approval by the successful Tenderer.

14.4.48 UHF SENSORS FOR PD DETECTION:

Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge up to 5 PC as per IEC 60270. The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (*APPLICATION GUIDE FOR SENSITIVITY VERIFICATION for UHF PARTIAL DISCHARGE DETECTION SYSTEM FOR GIS*) and CIGRE task force TF15/33.03.05 (Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the coustic method). Offered numbers and location of UHF sensors shall be submitted based on above said criteria along with attenuation calculation for approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments, Bus bar compartment, SF6 to air bushing, cable termination compartment based on proven range of detection of partial discharge to be indicated in SF6 gas partition drawing.
However adequacy of number of sensors and their location shall be verified at site as per recommendations of above CIGRE Document No. 654. In case during site testing, additional UHF sensors are required, the same shall also be supplied & installed to complete the technical requirement.

The calibration and frequency response of PD couplers shall be as per NGC Technical Guidance note TGN (T) 121, issue 1, 1997. **Data sheet shall be submitted for the UHF couplers meeting this requirement.**

Finish of Surface and Cleaning

The finish of interior surfaces of the GIS enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall not deteriorate when exposed to the SF6 gas and arc products, etc., that may be present in the enclosures. They shall not contain any substances which could contaminate the enclosed SF6 gas or affect its insulating properties over a period of time.

The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness. Before factory tests and packing for shipment, interior surfaces, insulators, barriers etc., must be thoroughly cleaned.

Supporting Structures

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied.

All the Anchor Bolts to be used in the GIS Shall be chemically galvanised.

Access has to be considered in the design of the structures to all equipment of the GIS. It has to be possible to surround the GIS with the gas cart.

The specified stresses for outdoor equipment like wind, earthquake, snow, ice and thermal expansion due to current and sun radiation have to be considered.

Proper surface treatment for all parts especially in outdoor situation has to be considered. All steel members have to be hot-dipped galvanized (indoor structures: 90 microns; outdoor structures: 130 microns) according to relevant Indian/International standards for heavily polluted environment.

Auxiliary Contacts

Each equipment shall be furnished with adequate number of electrically independent contacts at user's disposal. They shall be wired to terminals located in the local control cabinet of the circuit breaker bay. Installation of auxiliary relays (contact multiplication) may be used to meet the overall control and protection requirements.

14.4.49 GAS INSULATED BUS (GIB) LAYOUT :

GIB shall be designed based on the following criteria

(1) Maximum weight of gas in a gas tight section of GIB shall not exceed 400 Kg (for 400 kV)/ 250 Kg (for 220 kV & 132 kV).

(2) GIB shall be generally in horizontal layer. However in exceptional circumstance GIB in vertical layers with suitable support structures can be provided with the approval of AEGCL.

(3) The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters

(4) The horizontal clearance between GIB and GIS building /any other building wall shall be preferably three (3) meters.

(5) The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.

(6) The GIB clear height outside the GIS hall in switchyard area shall be minimum 3.5 meter, so as not to obstruct easy access to GIB, movement of crane for maintenance work.

(7) Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.

(8) For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.

(9) GIS manufacturer as per their design shall preferably use maximum three standard straight horizontal outdoor bus duct lengths for entire GIS installation to optimize the spare requirement.

(10) Special anti-corrosive measures shall be taken in bus ducts as per site condition.

14.4.50 EXTENSION OF GIS

16.4.46.1 The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

16.4.46.2 As the GIS is likely to be extended in future, during detailed engineering stage, the contractor shall make available the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to above, necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope. For 400kV GIS, in case one additional bay is required, the supplier has to provide all equipment necessary for the complete diameter with extension links kept outside the GIS building for future use.

16.4.46.3 The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remained isolated. Interface Module drawing with necessary detail shall be submitted for approval.

16.4.46.4 Further the contractor who is extending the existing GIS installation, it shall be his responsibility to provide interface module matching with the existing GIS interface module. The drawing of existing GIS interface/end piece module shall be provided by the employer. However it shall be the responsibility of contractor to verify the existing details during site visit.
The Contractor shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract.
For any type of bus bar configuration, it shall be possible to extend the switchgear by adding future feeders as decided by the owner with at least one of the bus bar systems in service continuously and the existing feeders remaining in service continuously. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect.

14.4.51 SF6 GAS

The tender shall include the supply of all SF6 gas necessary for filling and putting in commercial operation the complete switchgear installation with recommended extra quantity (minimum 10% extra). The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 60376, 60376A & 60376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC & should be suitable in all respects for use in the switchgear under all operating conditions.. Necessary statutory clearances from concerned authorities for import of the Gas and for storage of the Gas shall be obtained.

The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet latest Gas Cylinder Rules (PESO) SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:60376, 60376A& 60376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:60376, 60376A& 60376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for dew point and purity shall be done during commissioning of GIS. **Gas bottles should be tested for leakage during receipt at site.**The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections of GIS during service. The method proposed shall have as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

Spare SF6 cylinders shall be provided with Gas preservation system.

The contractor shall also submit clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

SF6 gas monitoring devices and alarm circuits: Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devicesshall provide continuous & automatic (ONLINE) monitoring of gas density. A separate device shall be provided for each gas tight compartment so that it can be monitored simultaneously as follows:-

Compartment/ Sl. No.	Compartments except CB	Circuit Breaker compartments
1	**"Gas Refill level:** This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication to SAS.	**'Gas Refill' level :**This will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication to SAS.
2	**"SF6 low level" :** This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication to SAS	**"SF6 low level" :** This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication to SAS

3	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.	**Breaker Block' level :** This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked. A contact shall be provided for remote indication to SAS
4	**Not Applicable**	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

The density monitor/pressure switch contacts shall be in accordance with the above requirement.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

Gas Supply: The contractor shall include the supply of all SF6 gas necessary for filling & putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

14.4.52 DOCUMENTATION

The contractor shall prepare and submit to the employer, drawings, details that show the GIS design in order for the employer to verify the equipment conform to the specifications. The Design Document to be submitted for review and approval are as follows:

i. Design Review Document
ii. Single Line Diagram
iii. Gas Schematic Diagram
iv. GTP-Guaranteed Technical Particulars
v. GIS layout (Plan and Section) including 3D drawing
vi. GIS Component Drawings
vii. Interface modules drawing for GIS extension
viii. Rating and Name Plate Drawing
ix. GIS/LCC Schematics Drawing
x. Foundation loading plan and detail
xi. GIS Support Structure Drawing
xii. GIS platforms and Walkway Drawing
xiii. GIS grounding plan and details along with design calculation for GIS grounding
xiv. GIS key Diagram enlisting and marking each and every GIS Module clearly and separately identifiable (indoor and outdoor). This separately identified module shallbe complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc.
xv. Method Statement along with sequential instruction for dismantling and assembling of all major components of GIS exhibiting service continuity requirement

xvi. Type Test Reports

xvii. Seismic Analysis Report

xviii. Study report of VFTO generated for GIS installation for 400 kV and above.

xix. The general arrangement drawing of interconnecting bus-duct from GIS bay moduleto XLPE cable termination end

xx. The general arrangement drawing of Terminal connection arrangement to connectGIS duct to SF6/Oil bushing and duct mounting arrangement details

xxi. Gas handling procedure

xxii. The design & construction proposal of the building along with necessary information, data, and drawings according to the complete requirements

xxiii. Capacity calculation of EOT crane for GIS hall considering a factor of safety of 5

xxiv. Method statement/ procedure of ON SITE high voltage testing with PD measurementand Switching Impulse test

xxv. Additional CB data to be furnished during detailed engineering :

a) Design data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 % fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
b) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.
c) Contact Travel: Operating mechanism operating shaft travel and contact overlapof Circuit Breaker to be provided

xxvi. PD Monitoring System The technical proposal for PDM system along with detailed design documentation.

a) Data sheet for the UHF couplers.
b) The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc., total numbers of offered UHF Sensors along with attenuation calculation.
c) Guaranteed Technical Particulars & Data Sheet for various components used in the PDM system.
d) Electromagnetic compatibility Test Reports.
e) List of critical spares.

xxvii. Installation and Operation & Maintenance Manual

xxviii) Temperature rise calculation of the GIS alongwith the thermal expansion data

xxix) Insulation coordination report

xxx) Transfer surge calculation with respect to GIS connection with transformer & reactor

14.5 TECHNICAL SPECIFICATION OF THE HIGH VOLTAGE COMPONENTS OF GIS

14.5.1 CIRCUIT BREAKERS

16.5.1.1 **General :** SF6 gas insulated metal enclosed circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification .

16.5.1.2 Circuit breakers shall be equipped with the operating mechanism. **Circuit breakers shall be of single pressure pufferred type design**. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing (as applicable) with an operating sequence and timing as specified.

Duty Requirements: Circuit breaker shall be C2 - M2- E2 class as per IEC 62271-100.

Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

Pre insertion resister: 400 kV circuit breakers for line bay (as per the provisions of bid proposal sheet) shall be provided with single step pre insertion closing resistors (wherever the requirement of PIR is explicitly specified so) to limit the switching surges to a value of less than 2.3 p.u for 400kV. PIR contacts should open immediately after closing of main contacts or At least 5 ms prior to opening of main contacts at rated air/gas pressure where the PIR contacts remain closed. The resistor shall have thermal rating for the following duties :

Terminal fault : Close.... 1 Min..... Open..... Close Open 2 min..... Close .....
1 Min Open Close Open.

Reclosing against trapped charges : Duty same as under (a.) above. The first, third and fourth closures are to be on de-energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. of opposite polarity.

Out of phase closing: One closing operation under phase opposition that is with twice the voltage across the terminals.

No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished during detailed engineering. The calculations shall take care of adverse tolerances on resistance values and time settings.

The circuit breaker shall be capable of: Interrupting the steady and transient magnetizing current shall be as follows:

Voltage Level	Type of Transformer	Rating (in MVA)
400kV	400/220kV	250 to 630
	400/132kV	160 to 315
220kV	400/220kV	250 to 630
	220/132kV	50 to 200
132kV	220/132kV	50 to 200
	132/33kV	10 to 50

a) Interrupting line/cable charging/capacitive current as per IEC without re-strikes and without use of opening resistors.. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of U/ 3 and 1.4

b) Clearing terminal fault (100%) & short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

c) Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

d) The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.

e) Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of atleast 15 minutes is acceptable).

f) Circuit breakers shall be able to switch in and out the shunt reactor as detailed below:

Voltage Level	Reactor Rating (in MVAR)	Max. rise of overvoltage(in p.u.)
400Kv	**50 to 150**	**2.3**
220kV	**25 to 50**	**2.3**

16.5.1.3 Total Break Time : The total break time shall not be exceeded under any of the following duties :

a) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100)

b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), pneumatic/hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

ractor may.

The values guaranteed shall be supported with the type test reports.

16.5.1.4 CONSTRUCTIONAL FEATURES :

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

16.5.1.7.1 If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.

16.5.1.7.2 Contacts: All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

16.5.1.7.2 Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

16.5.1.7.3 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

16.5.1.7.4 The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. power frequency voltage across the breaker continuously)

16.5.1.7.5 In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

16.5.1.7.6 Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for each substation covered under the scope.

16.5.1.7.7 Circuit Breaker shall be supplied with auxiliary switch having additional 10 NO (normally open) and 10 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired upto the local control cubicle.

16.5.1.7.8 The CO (Close-open) operation and its timing shall be such as to ensure complete travel/insertion of the contact during closing operation and then follow the opening operation.

16.5.1.7.9 The bidder has to verify whether the offered insulation level of the line end breakers is adequate for the respective transmission lines or not.

16.5.1.5 OPERATING MECHANISM

16.5.1.8.1 **General Requirements:**

a) Circuit breaker shall be operated by spring charged mechanism or hydromechanical spring mechanism.

b) The mechanism shall be housed in a dust proof cabinet and shall have IP: 55 degree of protection.

c) The operating mechanism **box** shall be strong, rigid, rebound free and shall be readily accessible for maintenance.

d) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

e) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker.

f) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. **A non-resettable operation counter shall also be provided.**

g) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

h) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

i) The duty cycle for the CB shall be O-0.3s-CO-3 min-CO.

16.5.1.6 CONTROL

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch shall be provided in the breaker control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operatingrod.

16.5.1.7 SPRING OPERATED MECHANISM (SPRING-SPRING)

a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one O-CO operation shall be possible with the energy stored in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS .

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

j) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.

k) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.

l) An overload relay shall be provided for protection of the spring charging motor.

16.5.1.8 CONTROLLED SWITCHING DEVICE (CSD):

16.5.1.11.1 400KV Circuit Breaker shall be equipped with controlled switching device with consequent optimization of switching behavior, when used in:

1. Switching of transformer (from 400kV side circuit breakers only). **CSD application for 220kV**

transformer switching shall also be evaluated as per the SLD requirement.

2. Switching of line and bus reactor.

3. Switching of line (>200km) CSD will be preferred to PIR

16.5.1.11.2 The CSD shall be provided in 400kV Circuit breakers for controlling transformers and reactors (ie for breakers of switchable line reactor and in Main& Tie circuit breakers of Transformers, Transmission lines with non-switchable line reactors and Bus reactors). The requirement of CSD shall be explicitly specified in price schedule

16.5.1.11.3 Technical Requirement for Controlled switching device:

a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as per requirement.

b) The CSD shall meet the requirements of IEC-61000-4 16 class IV regarding HF disturbance test and fast transient test shall be as per IEC-61000 – 4-4 level IV and insulation test as per 60255 – 5.

c) The CSD shall have functions for switching ON & OFF the circuit breakers.

d) The CSD shall get command to operate the breakers manually or through auto re- close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

e) The CSD shall have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of net operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5 ms.

f) The CSD shall have communication port to facilitate online communication of the control switching device with SCADA directly on 61850 or through gateway which shall be under present scope.

g) The CSD shall be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.

h) The CSD shall be suitable for current input of 1 amp from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The controller shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.

i) The CSD shall have time setting resolution of 0.1 ms or better.

j) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

k) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

l) The provision for bypassing the Controlled switching device shall be provided through BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit Breaker. Alternatively, in case of any non-operation of the CSD after receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.

m) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on

IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

16.5.1.9 TESTS :

Type Tests:

i. The circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271- 100.

ii. The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval

iii. Circuit breakers meant for controlled switching shall conform to requirements of IEC/TR-62271–302. The contractor shall submit test reports to demonstrate that the offered CB conforms to the requirements of performance verification tests and parameter definition tests as per IEC/TR 62271-302. The contractor shall also furnish the report for the re-ignition free arcing window for switching 3-phase shunt reactor as demonstrated in the shunt reactor switching test.

16.5.1.10 ROUTINE TESTS:

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following shall alsobe performed.

i. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating **control** voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be **arranged by the contractor at his** own cost. After completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to AEGCL.

ii. During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test.

iii. Routine tests on Circuit breakers with Controlled switching device as per IEC/TR 62271-302.

16.5.1.11 DISCONNECTORS (ISOLATORS)

16.5.1.14.1 Disconnectors shall be three-pole group operated or Single-pole individual operated (as per single line diagram of the substation) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC-62271-102 and shall have the ratings as specified in BPS.

16.5.1.14.2 CONSTRUCTION & DESIGN.

16.5.1.14.2.1 The disconnectors shall be operated by electric motor suitable for use on DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shallbe protected against over current and short circuit.

16.5.1.14.2.2 Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all three test duties viz TD1,TD2 and TD3 as per Annexure –F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordancewith Annexure –B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these

currents are interrupted.

16.5.1.14.2.3 The disconnect switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

16.5.1.14.2.4 It shall be possible to operate the disconnect switches manually by cranks or hand wheels.

16.5.1.14.2.5 For motor-operated disconnect switches, the control should be electrically and/or mechanically uncoupled from the drive shaft when the switch is operated manually to prevent coincident power operation of the switch and the drive mechanism(s).

16.5.1.14.2.6 The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

16.5.1.14.2.7 The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located inthe Local Control Cabinet (LCC).

16.5.1.14.2.8 Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.

16.5.1.14.2.9 The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

16.5.1.14.2.10 Each disconnector shall be supplied with auxiliary switch having additional 8 NO (Normally Open) and 8 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired up to the local control cabinet.

16.5.1.14.2.11 The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current,peak withstand current and short-time withstand current can be carried safely.

16.5.1.14.2.12 The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

16.5.1.14.2.13 The disconnectors and safety grounding switches shall have mechanical/electrical inter- locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

16.5.1.14.2.14 The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with theremote/local transfer switch set to local.

16.5.1.14.2.15 All electrical sequence interlocks will apply in both remote and local control modes.

16.5.1.14.2.16 Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

16.5.1.14.2.17 All the disconnecting switches shall have arrangement allowing easy

visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

16.5.1.14.2.18 The disconnecting switches shall be provided with rating plates and shall be easily accessible.

16.5.1.14.2.19 The mechanical endurance class shall be M2 as per IEC for 400kV, 220 kV and 132kV disconnectors. **Electrical endurance class shall be E2.**

16.5.1.14.2.20 Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) and SAS.

16.5.1.14.2.21 Manual operation facility shall be provide for each disconnector in the GIS.

16.5.1.14.2.22 The degree of protection for the Drive Mechanism box of disconnector shall be IP55.

16.5.1.14.2.23 Disconnect switch shall be capable of switching inductive currents as per IEC 60129 and bus transfer as per IEC 61128.

16.5.1.12 SAFETY GROUNDING SWITCHES

16.5.1.15.1 Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation). It shall be operated by DC electric motor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

16.5.1.15.2 Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such that it can only be closed if both the circuit breaker and disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.

16.5.1.15.3 Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC)and provision for taking the signal to Control room.

16.5.1.15.4 The details of the inscription and colouring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

16.5.1.15.5 Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

16.5.1.15.6 Each ground switch shall be fitted with auxiliary switches having 6 NO (Normally Open) and 6 NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.

16.5.1.15.7 Provision shall be made for padlocking / suitable locking arrangement for the ground switches in either the open or closed position.

16.5.1.15.8 All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross- sectional area of 100 sq. mm.

16.5.1.15.9 The main grounding connections on each grounding switch shall be rated to carry the full short circuit current for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

16.5.1.15.10 The safety grounding switches shall conform to the requirements of IEC-62271- 102 and shall have electrical endurance class: E2 & shall have mechanical endurance class M2 for 400 kV/220/132 kV voltage level..

16.5.1.15.11 The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.

16.5.1.15.12 Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.

16.5.1.15.13 Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

16.5.1.15.14 Manual operation facility shall be provided for the earth switches.

16.5.1.15.15 The degree of protection of the Drive Mechanism box of maintenance earth switch shall be IP55.

16.5.1.15.16 Termination point grounding switch shall be able to make short circuit current and capable of breaking the induced capacitive and inductive current as per IEC 61129 (Class-B duty) considering the transient recovery switching duty imposed on grounding switch.

16.5.1.13 HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall confirm to class F and electrical endurance class E2 and mechanical endurance class M2.

16.5.1.16.1 High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.

16.5.1.16.2 The switches shall be fitted with a stored energy closing system to provide fault making capacity.

16.5.1.16.3 The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating as specified. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

16.5.1.16.4 Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.

16.5.1.16.5 The details of the inscription and colouring for the indicator shall be as under:-

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

16.5.1.16.6 High speed ground switch operation should be possible locally from Local Control Cabinet (LCC) as well as from SAS.

16.5.1.16.7 These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

16.5.1.16.8 Each high speed ground switch shall be fitted with auxiliary switches having additional 6 NO (Normally Open) and6 NC (Normally Closed) contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the Local Control Cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

16.5.1.16.9 All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 120 sq. mm.

16.5.1.16.10 The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for **3 sec. and shall be equipped with a silver-plated contacts and to be connected to copper flat riser outside the earthing switch module.**

16.5.1.16.11 The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.

16.5.1.14 INSTRUMENT TRANSFORMERS

16.5.1.17.1 Current Transformers The current transformers and accessories shall conform to IEC: 61869 and other relevant standards except to the extent explicitly modified in the specification.

a) Ratios and Characteristics: The CT core distribution for various voltage levels shall be as per SLD. Further the numbers of cores, rating, ratios, accuracy class,etc. for the individual current transformers secondary cores shall also be as per the details mentioned in the scope. The knee point voltage of the CTs shall be minimum of 1:1 ratio of the rating of the CT cores. However, the exact requirement of knee point voltage shall be determined by CT sizing calculation which is to be provided during detailed engineering.

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

b) Rating and Diagram Plates: Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated current & extended current rating in case of current transformers and rated voltage, voltage factor & intermediate voltage in case of voltage transformers shall be clearly indicated on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

The Vk value of the CT used for distance protection shall have transient performance as per IEC 60044-6

A) Constructional Details:

i) The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal- enclosed type.

ii) Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

iii) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

iv) The rated extended currents for 800 kV and 420 kV class Current transformers shall beas given below:

Tap Ratio	800kV, 3000A	400kV, 3000A
	Rated extended currents in % of rated current	
500/1	200	200
1000/1	---	---
2000/1	180	180
3000/1	120 (200 for 15 min)	120

v) The secondary winding shall be rated for 2A continuously.

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

vi) For 800/420/245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

v i) For 800kV CTs, the instrument security factor at all ratios shall be less than ten (10) for metering core. For 420/245/145kV 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.

i) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.

ii) The current transformers shall be suitable for high speed auto-reclosing.

iii) Provisions shall be made for primary injection testing either within CT or outside.

x i) All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

16.5.1.17.2 VOLTAGE TRANSFORMERS

The voltage transformers shall conform to IEC- 61869 and other relevant standards exceptto the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought outin the terminal box.

a) **Ratios and Characteristics**: The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Annexure 4 & Table 4A.

b) **Rating and diagram plates** :Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.
Second`ary Terminals, Earthing

A) The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

The transformer shall be able to sustain full line to line voltage without saturation of transformer.

d) Constructional Details of Voltage Transformers :

i) The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.

ii) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to the capacitance of the GIS.

ii) The voltage transformers shall have three secondary windings.

iv) Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably RING type non-disconnecting terminal blocks in the secondary boxes via the MCBs.

v) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

vi) The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 100 VA on all the three windings without any adjustments during operation. .

vi**i**) The diagram for the interconnection of the VTs shall be provided inside secondaryterminal box.

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

ix) PT shall be provided with isolating link through external operation for the purpose of high voltage testing of GIS.

16.5.1.17.3 Tests:

i. In accordance with the requirements in Section-GTR, Current Transformer and Voltage Transformer should have been type tested and shall be subjected to routine tests in accordance with relevant IEC.

ii. The test reports of type tests, as applicable, as per IEC-61869-2 for CT, and IEC-61869-3 for IVT and following additional tests shall be submitted for the Employer's review. Thetype tests for which the procedure is under consideration as per above said IEC is not required to be considered.

a) Current Transformers (CT): Transmitted over voltage test for 145kV and above voltage rating

b) Inductive Voltage Transformers (IVT): Transmitted over voltage test for 145kVand above voltage rating

16.5.1.15 SURGE ARRESTORS

16.5.1.18.1 The surge arrestors shall confirm in general to latest IEC –60099-4.

16.5.1.18.2 **I**

Insulation co-ordination and selection of surge arrestor: The contractor shall be fully responsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer.

16.5.1.18.3 T

The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

16.5.1.18.4 T

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

16.5.1.18.5 **D**

Duty requirements of GIS Surge Arrestor

16.5.1.18.7.7 The surge arrestor shall be SF6 gas insulated metal oxide and gapless type. The metal housing of the arrestor shall be connected to the metal enclosure of the GIS with flange, bolted and gasketed joint so that the arrestor housing is grounded through GIS enclosure.

16.5.1.18.7.8 Surge arrestor shall be disconnect-link type and be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system while the system is being dielectrically tested.

16.5.1.18.7.9 The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

16.5.1.18.7.10 The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

16.5.1.18.7.11 Surge arresters for the 765 kV network shall be capable of discharging of severe re- energisation switching surges on a 765kV line with surge impedance of 270hms and capacitance of 13 nF/Km.

765 kV class arrester shall be capable of discharging energy equivalent to class 5 of IEC for a 765 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

1000 kVp for 3 peaks

910 kVp for 0.1 Sec.

885 kVp for 1 Sec.

866 kVp for 10 Secs.

16.5.1.18.7.12 Surge arresters for the 400 kV network shall be capable of discharging of severe re- energisation switching surges on a 400 kV, 450 Km long line with surge impedance of 300 ohms and capacitance of 12 nF/Km and over voltage factor of 2.3 p.u at the arrestor terminals.

400 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 400 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

650 kVp for 3 peaks

575 kVp for 0.1 Sec.

550 kVp for 1 Sec.

475 kVp for 10 Secs.

16.5.1.18.7.13 245 & 145kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV & 145 kV system respectively on two successive operations.

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

16.5.1.18.7.15 The surge arresters are being provided to protect the followings whose insulation levels areindicated in the table given below:-

Equipment to be protected	765kV system		400kV system		220KV system	132KV System
	Lightning impulse(kVp)	Switching surge (kVp)	Lightning impulse (kVp)	Switching surge (kVp)	Lightning impulse (kVp)	Lightning impulse (kVp)
Power Transformer	± 1950	± 1550	± 1300	± 1050	± 950	± 550
Instrument Transformer	± 2100	± 1550	± 1425	± 1050	± 1050	± 650
Reactor	+ 1950	+ 1550	+ 1300	+ 1050	-	-
CB/Isolator Phase to ground	± 2100	± 1550	±1425	± 1050	± 1050	± 650
CB/Isolator Across open contacts	± 1300 (-/+457)	± 1200 (-/+653)	± 1425 (-/+240)	± 900 (-/+345)	± 1200	± 750

16.5.1.18.6 **Constructional Features**

The nonlinear blocks shall be of sintered/infered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

16.5.1.18.7 **Tests**

16.5.1.18.7.1 In accordance with the requirements stipulated, the surge arrestors shall conform to typetests and shall be subjected to routine and acceptance tests in accordance with IEC document.

16.5.1.18.7.2 Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

16.5.1.18.7.3 Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse,(8/20 micro sec.) shall also be performed on the surge monitor.

16.5.1.18.7.4 **Technical** Parameters: Technical parameters are as per Annexure 5.

16.5.1.16 OUTDOOR SF6/AIR BUSHINGS :

16.5.1.19.1 Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTP.

16.5.1.19.2 The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

16.5.1.19.3 Bushings shall generally be in accordance with the requirements of IEC -60137.

16.5.1.19.4 Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

16.5.1.19.5 The creepage distance over the external surface of outdoor bushings shall not be less than 31mm/Kv.

16.5.1.19.6 Bushing types and fitting: The details of bushing shall be as follows:

- SF6 to air Bushing shall be of Polymer/composite type or better and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC:60137. All details of the bushing shall be submitted for approval and design review.
- Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462.

16.5.1.19.7 **Mechanical forces on bushing terminals:** Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/Al tube on the other side and short circuit forces.Type test reports as per applicable IEC

including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in section GTR for approval.
The technical parameters of Bushing are as per GTP.

Corona rings shall be provided for SF6 to air bushing for 220kV and above voltage level.

16.5.1.17 GIS TO CABLE TERMINATION (IF APPLICABLE)

16.5.1.21.7 This scope covers the supply, erection, commissioning of connection assembly of extruded cables to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-209

16.5.1.21.8 The XLPE cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure.

16.5.1.21.9 The GIS to XLPE cable termination shall conform to IEC-62271-209.

16.5.1.21.10 The rating of XLPE cables for different voltages shall be as per BoQ.

16.5.1.21.11 The limits of supply of gas-insulated metal-enclosed switchgear and the cable termination shall be in accordance with IEC 62271-209.

16.5.1.21.12 Cable termination and cable connection enclosure shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

16.5.1.21.13 The SF6 cable end unit and connection support structure should be equipped with provisions for isolating and grounding of the cable sheath as per the requirement of cable sheath bonding system or pipe to permit cathodic protection of cable system (seeIEC62271-209)

16.5.1.21.14 The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolationgap shall be provided by the GIS manufacturer.

16.5.1.21.15 All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the Employer.

16.5.1.21.16 The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

16.5.1.18 TRANSFORMER / REACTOR TERMINATION

16.5.1.21.1 **TRANSFORMER / REACTOR Direct Connection with GIS (if applicable)**

16.5.1.22.2 .7 The scope covers the supply, erection and commissioning of connection assembly of Oil filled Transformer to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-211.

16.5.1.22.2.8 The limits of supply of gas-insulated metal-enclosed switchgear and the direct connection to oil filled transformer shall be in accordance with IEC 62271-211.

16.5.1.22.2.9 The transformer / reactor termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fitting.

16.5.1.22.2.10 Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's approval and for co-ordination with transformer and reactor supplier. Any modification suggested by transformer and reactor supplier shall have to be carried out by the GIS supplier to facilitate proper connection with the bushings of the transformer and reactors.

16.5.1.21.2 TRANSFORMER / REACTOR CONNECTION WITH SF6/AIR BUSHING

The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respective Transformer/Reactor supplier and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope.

In case of single phase Transformers/Reactors are being installed in the substation, HV&IV auxiliary bus for the Transformer/Reactor bank for connecting spare unit shall be formed inside the GIS hall as per the SLD furnished and as specified in Section project.

16.5.1.19 LOCAL CONTROL CUBICLE (LCC)

16.5.1.22.1 Functions

16.5.1.22.1.1 Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore/indicating lamp for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls beingin operation simultaneously.

16.5.1.22.1.2 Status indications in the LCC shall be semaphore type or LED type.

16.5.1.22.1.3 Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.

16.5.1.22.1.4 If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

16.5.1.22.1.5 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc .

16.5.1.22.1.6 Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. In plug in connector type cable arrangement, min 2 cores of the cable with connected condition on both side up to the TB to be left unused as spare.

16.5.1.22.1.7 Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.

16.5.1.22.1.8 LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS

16.5.1.22.2 Constructional Features

16.5.1.22.2.1 Local Control cubicle shall be free standing, floor mounting type (Standalone). Bay mounted LCCs are not accepted. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation. Alternatively folded sheet panels of adequate thickness and strength is also acceptable. Minimum degree of protection of enclosure of LCC shall be IP55

16.5.1.22.2.2 Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers (if required) having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM gaskets conforming to the provision of IS 11149.

16.5.1.22.2.3 For LCC panel of each feeder bay (i.e. line, transformer, and reactor etc.), Bus Coupler bay and Bus Sectionalizer bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB/DCDB. The control DC supply (for

control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loop in Loop out AC Supply can be provided.

16.5.1.22.2.4 Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier baseshall have imprints of the fuse 'rating' and 'voltage'.

16.5.1.22.2.5 Each LCC Panel shall be provided with the following

1. **Plug Point**: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
2. **Interior Lighting**: Each panel shall be provided with a door-operated LED lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.
3. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

16.5.1.22.2.6 Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof IP-65 cubicles.

16.5.1.22.2.7 The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door, that allows a complete view of the annunciator and mimic diagram when the LCC door is closed. Necessary protection shall be provided to avoid inadvertent operation of control switches.

16.5.1.22.2.8 An interlocking scheme shall be provided that takes into account the following basic requirements.

- To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
- prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.

16.5.1.22.2.9 Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

16.5.1.22.2.10 Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency- tripping device shall be kept separate and distinct from the key interlocking.

16.5.1.22.2.11 Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

16.5.1.22.2.12 Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.-

16.5.1.22.2.13 All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already

closed.

16.5.1.22.2.14 Separate DC supply with changeover facility shall be provided in the LCC for control and power requirement of the GIS bay components and local alarm/indication.

16.5.1.20 CABLING BETWEEN LCC PANEL AND GIS EQUIPMENT

16.5.1.23.1 The armoured screen cable shall be of 1.1kV grade, multicore, annealed copper conductor, Tinned copper braided screen (approx.85%coverage). This cable shall be shielded upto 10MHzand earthed at both ends through double compression gland.

16.5.1.23.1 The core insulation and outer sheath of cable shall be of halogen-free special polymer.

16.5.1.23.2 The cable shall be flame-retardant, flexible, abrasion-and wear-resistant.

16.5.1.23.3 The size of core shall not be less than 2.5 sq. mm for instrument transformers and 1.5 sq. mm for other control cable.

16.5.1.23.4 Prefabricated cables with heavy duty multi-point plug-in connections on GIS end shall be provided.

16.5.1.23.5 All instrument transformer connections shall be hard wired to terminal block via ring type connection.

16.5.1.21 GIS BUILDING

16.5.1.24.1 The buildings shall house each voltage class Gas Insulated Switchgear (GIS) and other associated equipment inside each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per project requirement including space for future bays.

16.5.1.24.2 For finalizing the dimensions of GIS building the requirement of Turning radius to rotate the largest removable component for assembly/disassembly shall be taken in to consideration along with the gas cart movement & high voltage test bushing etc. around the GIS module.

16.5.1.24.3 Wherever GIS Building of already exists, then the existing GIS Building(s) for respective voltage class shall be suitably extended keeping the width of the building same to accommodate the number of bays/diameters as specified in the Project.

16.5.1.24.4 The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.

16.5.1.24.5 The area for GIS Building(s) is indicated in the tender document. The area given is for reference only and may vary according to the requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

16.5.1.24.6 The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, Communication panels etc. in a separate Relay Panel Room in the GIS building. The size of the room shall be such that all the panels for the bays/ diameters shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers.

16.5.1.24.7 For cable termination type GIS design, cable cellar room shall be considered as a part of GIS building.

16.5.1.22 ELECTRIC OVERHEAD CRANE:

16.5.1.25.1 One EOT Crane each for GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipment. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component crane.

16.5.1.25.2 The Crane shall be used for the erection and maintenance of the GIS switchgear component and all plant installed in the GIS switchgear room. On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking

Over Certificate is issued. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the plant area.

16.5.1.25.3 The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.

16.5.1.25.4 The crane shall have minimum speeds under full load of:

i. Hoisting Speed 2 meters/minute
ii. Cross Travel 16 meters/minute Long Travel 20 meters/minute
iii. Creep speed shall be of25% of operating speed

16.5.1.25.5 The electric overhead cranes shall be provided with walkways, platforms. LT platforms shall be provided on non DSL side. Guard hand rails shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul. An access platform shall be provided together with a guarded ladder on the crane to allow access to the bridge rails.

16.5.1.25.6 The crane shall be possible to be operated through the cable, through the pendant control and which shall be easily accessible from the floor of GIS building and through remote control device. Manufacturer/contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of 5.

16.5.1.25.7 The crane for 132kV GIS shall have minimum height of 8.0 meters & 220kV GIS shall have minimum height of crane of 9.0 meters and for 400kV GIS it shall have minimum height of 10.5 meters or as per actual requirement whichever is higher. In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders to facilitate movement of EOT crane in the extended portion of GIS hall.

16.5.1.25.8 The following tests should be performed for EOT Crane:

16.5.1.25.9 The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.

16.5.1.25.10 Further the following tests may be done at site after installation of the crane at site a. Check althea accessories for proper function.

16.5.1.25.11 The following tests may be EOT Crane:- The following tests may be EOT Crane:-

a. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.
b. Further the following tests may be done at site after installation of the crane at site
i. Check all the accessories for proper function
ii. No load test
iii. Load test as per site conditions. (with 25% overload)

16.5.1.25.12 Constructional Details

16.5.1.25.12.1 The double web, box construction crane bridge girders shall be in one piece or in pieces suitable for transportation. If the design is of multi piece construction, it shall require the approval of the Engineer in Charge. Cross travel rails shall be fixed to the bridge girders by clamping only and not welding. Plates, bars, angle sections and where practicable other rolled sections, used in the load bearing members of structures shall be not less than 8 mm thickness. The end Carriages shall be of double web plate box construction or I section connected to the girders by welding at top or by large gusset plates and fitted bolts to ensure maximum rigidity. Drop stops and jacking pads shall be built-in features. Full length plate form of checker plate of minimum thickness 8 mm shall be provided along both sides of the crane to ensure easy, safe excess to the crane crab, travel gears and other parts. Safety railing shall be provided on crane bridges and crab frame. Foot-walk shall have sufficient width to give 500 mm minimum clear passage at all points, EOT Crane shall be single girder (upto 5T for132kVVoltage level) and double girder (above 5T for 220kV and above voltage level).Voltage level) and
double girder (above 5T for 220kV and above voltage level).

16.5.1.25.12.2 EOT Crane shall be double girder.

16.5.1.25.12.3 Rope Drums

Rope drums shall be of cast steel or fabricated from seamless tubes, conforming to the relevant Indian Standards. Fabricated rope drums shall be stress relieved before any machining takes place. The sizing of drum shall conform to IS 3177 Clause 5.

16.5.1.25.12.4 Rope Sheaves

Rope sheaves shall be of cast steel or fabricated from rolled steel plates, conforming to Clause 6 of IS 3177.

16.5.1.25.12.5 The wires shall **be steel cored** for all cranes. Ropes shall be of regular right hand lay as per IS 2266. The rope construction shall be 6 x 37 up to 16 mm diameter and 6 x 36 above 16 mm diameter, with a factor of safety specified as per Clause 5.6.1 of IS 3177. **Wire rope calculation shall be carried out by considering N-1 falls (number of ropes) to take care of 125% load.**

16.5.1.25.12.6 Hook Block

The sheaves shall be fully encased in close fitting guards fabricated from steel plate. Smooth opening shall be provided in the guards to allow for free movement of the rope. Holes shall be provided for oil drainage.

16.5.1.25.12.7 Lifting Hooks

The lifting hook shall be one that will best suit this type of crane and as per IS 3177. Hooks shall be type tested by a third-party agency such asSGS or Lloyds..

16.5.1.25.12.8 Gears and Gear Boxes

Straight and helical spur gearing shall be used for all motions. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and shall be of tempered alloy steel having metric module. Overhung gears shall not be used. The design and general arrangement of gear boxes shall be as per Clause 10 of IS 3177. All gearing shall be totally enclosed/immersed in oil.

16.5.1.25.12.9 Track Wheels

Crab/Crane wheels shall be double flanged. Wheels shall be mounted in anti-friction roller bearings housed in “L” shaped bearing brackets for ease of removal during routine maintenance. Solid wheels shall be of forged/rolled steel or cast steel. In general, the track wheels shall conform to Clause 11 of IS 3177.

16.5.1.25.12.10 Rails

The rails shall be specified as being suitable for the crane duty used; no square bars will be acceptable. The rails shall be complete with end stops, holding down bolts and taper washers and shall be suitable for connection to the station earth. Access to the crane for maintenance purposes from the walking plate form by means of a steel ladder with cage shall be provided at **non-DSL** end. The crane shall be provided with full length walkway on drive side girder and small walkway on another girder.

Walkway shall be at least 500 mm clear inside. **The rails shall be copper headed steel of type tested design.**

DSL bus bar shall be PVC shrouded copper bus bar. Buffer/Stopper shall be designed with steel with spring & rubber cushioning suitably placed to take the impact of the crane.

16.5.1.25.12.11 Couplings

All couplings shall be of steel or cast iron of grade 260 conforming to IS 210 and shall be designed to suit the maximum torque that may be developed. The manual drive shaft and hoist drum shall be connected to the gear box input shaft through a flexible shock absorbing coupling as per Clause 8 of IS 3177.

16.5.1.25.12.12 Bearing and Bearing Housing

Anti-friction bearing housings shall be used throughout, except where required otherwise for technical reasons, conforming to Clause 7 of IS 3177.

16.5.1.25.12.13 Shafts

All shafts shall be made of steel as per Clause 9 of IS 3177.

16.5.1.25.12.14 Electrical details

The general technical details for the electrical systems specified elsewhere in the document will apply to the electrical equipment for the gantry crane also. The following points deal with the special requirements for the crane. In case of any contradiction with the electrical specifications described elsewhere in this document, the special requirements detailed hereafter shall govern.

415 V, 3 Phase, 4 wire electric power supply will be available at one point for the crane bus. The Tenderer shall provide a metal enclosed switch box housing a 250 A MCCB TPN switch, CT operated ammeter and voltmeter, with selector switch. This switch box shall be located approx. 1.2 meters above the floor level. The incoming cable must be of suitable size copper conductor, PVC insulated, PVC sheathed, strip armoured. From this

switch onwards, the Tenderer shall arrange and terminate the supply at the crane bus.

16.5.1.25.12.15 Crane Power Supply

415 Volts +/- 10%, 3 Phase, 4 Wire, 50 Hz +/- 5%, AC through trolley lines. Current Collector

Two No. per trolley line shall be provided; each rated for 100% of total crane rating. Double collectors on each earth trolley shall be provided and these shall be different from those on the power trolley line. Collector rollers and shoes shall be designed to reduce sparking to the minimum level possible Power Distribution on Crane. An off/load manual isolator, with a locking facility shall be provided immediately after the current collectors on the incoming line on the crane.

Power from the isolator shall be taken to the circuit breaker located in protective panel of the crane. The breaker shall be provided with under voltage, overload and short circuit release or relays. The breaker can only be closed when:

All controllers are in neutral position;

None of the stator or directional contactors are in closed position; Door/gate switches are not actuated;

Rotary and gravity limit switches for hoist motion not operated.

16.5.1.25.12.16 Power Supply for Lighting and Magnet Circuits

Power for lighting and magnet circuits shall be tapped from the incoming side of isolator near current collectors.

16.5.1.25.12.17 Power Supply for Cross traverse Motion

A flexible traveling crane system mounted on a retracting support system shall be used. The conductor shall consist of insulated multi-conductor or several single conductor cables with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. The clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cables. The flexible copper cables shall be of butyl rubber or EPR insulated CSP sheathed type 650/1100 V Grade.

16.5.1.25.12.18 Panels

All panels shall be of free-standing floor mounted construction, suitable to withstand any vibrations emanating from the crane. The panel and its components shall conform to standards of Electrical Technical Specifications for LT Switchgear/Panel, described elsewhere in this document.

16.5.1.25.12.19 Motors

Heavy duty motors suitable for crane operation, shall be reversible, suitable for frequent acceleration and mechanical breaking, totally enclosed, fan cooled, SCIM type. The duty of the motor shall be S5, as per IS 325. Class of insulation shall be “F” with temperature limited to class B. The pull-out torque is to be not less than 225% of full load torque, corresponding to 40% CDF (Cycle Duration Factor of the motor). The main motor shall have the speed ranges suitable for gearbox and operating speed for a Class 2 crane.

16.5.1.25.12.20 Brakes shall be provided for hoisting motions. Brakes shall be thruster type. DCEM brakes in combination can also be used. No converted DC shall be used in crane. Brakes shall be designed to be fail-safe whenever there is a current interruption, either intentionally or by main power supply failure. The capacity of brakes, brake drums, shoes and brake adjustment shall be as per Clause 14.4 of IS 3177.

16.5.1.25.12.21 Limit Switches

Only drum limit switches are acceptable. Roller operated, resetting limit switches shall be provided for all motors. For each hoist motion, a rotary type over-winding self-resetting limit switch shall be provided. An indication shall be provided to the operator whenever this limit switch has been operated. Limit switches shall be fitted to prevent over travelling and over traversing and any other special requirements.

16.5.1.25.12.22 Resistance

Resistances shall be air-cooled, robust, heavy duty, corrosion resistant, punched stainless **steel grid type** resistor. Suitable tapping points shall be provided. Resistance boxes shall be mounted in racks that permit independent travel of any

selected box.

16.5.1.25.12.23 Pendent Controller Pendent push button station shall comprise of the following and be suitable for 110 V AC:

1. Key operated ON push button-standard green button on signal lamp-green lens.
2. Emergency OFF push button-standard red button.
3. Hoisting push button- standard black button.
4. Lowering push button-standard yellow button.
5. Cross traverse forward push button- standard black button.
6. Cross traverse reverse push button- standard black button.
7. Long traverse forward push button- standard black button.
8. Long traverse reverse push button- standard black button.
9. Crane light ON/OFF push button.
10. Bell ON/OFF push button
11. Radio control system interlocked with the pendant push button station to prevent any mal-operation.
12. All other standard push buttons shall be provided. Push button station shall be suitably earthed through flexible cable. Indication lamp for functioning error shall be provided.

14.6 SEISMIC DESIGN CRITERIA:

The equipment shall be designed for operation in seismic zone V for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipment along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. Test Report/Analysis Report should be furnished.

14.7 DESIGN REVIEW

14.7.1 Design reviews shall be conducted by Employer; however the entire responsibility of design shall be with the supplier.

14.7.2 Employer may also visit to the supplier's works to inspect design, manufacturing and test facilities.

14.7.3 The design review will commence after placement of award with the successful contractor and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer reserve the right to waive off the design review during detailed engineering.

14.7.4 The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGRE report No. 125 prepared by CIGRE Working Group 23.10.

14.7.5 The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric, insulation coordination and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

14.7.6 The scope of such a design review shall at least include the following:

The scope of such a design review shall at least include the following:		
1.	Dielectric Stress of Solid Insulation like Gas Barrier, support insulator etc.	
2.	Dielectric stress of SF6 Gas Volume.	
3.	Mechanical strength of enclosure, expansion joints etc.	
4.	Criteria for providing expansion joint.	
5.	Sealing system	

	6.	Insulation coordination		
	7.	Thermal stress and resulting increase in gas pressure during short circuit condition.		
	8.	Earthing of enclosure w.r.t circulating current.		
	9.	Seismic design, as per IEC 62271-207		
	10.	Circuit Breaker.		
	11.	Isolator and Earth switch.		
	12.	Voltage transformer.		
	13.	Current Transformer.		
	14.	Surge Arrester.		
	15.	Bushing.		
	16.	***Bus duct***		
	17.	Co	rrosion protection.	
	18.	Ele	ctrical and physical Interfaces with substation.	
	19.	Te	sting capabilities.	
	20.	In	spection and test plan.	
	21.	Transport and storage.		
	22.	Maintainability.		
	23.	Site Test.		
	24.	***Proper Interfacing of High voltage test bushing.***		
	25.	***TEV calculation for proper designing of insulators and bushings.***		
	26.	***Ferro Resonance test report for GIS VT***		
	27.	***Calculation of thermal expansion due to temperature rise in GIS.***		

14.7.7 Further, the manufacturer shall furnish the following information during detailed engineering:

a) Study report of VFTO generated for GIS installation for 400 kV and above.

b) Calculation for adequacy of UHF sensors to be provided in GIS Installation

c) The calculations and documents in support of the average intensity ofelectromagnetic field on the surface of the enclosure.

d) Calculations to show that there is no Ferro resonance due to capacitance of GIS forthe voltage transformers.

e) Calculations in support of touch & step voltages in all enclosures and earthing ofcomplete GIS installation.

f) Measures to mitigate transient enclosure voltage by high frequency currents.

g) The acceptance criteria and limits of impact (of impact recorder) in all three directions which can be withstood by the equipment during transportation and handling.

14.8 TYPE TESTS

The offered GIS equipment shall conform to the type tests as per IEC-62271-203.Contractor shall submit type test reports for the following type tests & additional type tests.

Sl.	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3	Tests to prove the ability of the main and earthing circuits to carry the rated peak and rated short time withstand current
4	Tests to verify the making and breaking capacity of the included switching Devices
5	Tests to prove the satisfactory operation of the included switching devices
6	Tests to prove the strength of the enclosures
7	Gas tightness tests
8	Tests on partitions
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on Insulators
13	Additional tests on auxiliary and control circuits
14	Reactor current switching test For Reactive Current switching capability as per Clause 6.4.1
15	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure.
16	Electromagnetic compatibility tests (if applicable)
17	Radio inference voltage tests
18	Test report for 10Kv Insulation earth switch,
19	Test report of operating mechanisms for all the duties.

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnect Switch, Grounding switches, Current and Voltage transformers as per relevant IEC and type tests of SF6/Air & Oil bushing as per IEC 60137 shall be submitted for approval as per Section- GTR, Technical Specification.

14.9 MISCELLANEOUS

14.9.1 **Painting of enclosure**: All enclosures shall be painted externally as per manufacturer'spainting procedure.

14.9.2 **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensationinside various Marshaling boxes.

14.9.3 Identification & Rating plate

Each bay shall have a nameplate showing

a) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnect Switch Grounding switches, Current transformer, Voltage transformers, Surge arrester etc shall be as per their relevant IEC.

b) A schematic diagram indicating their relative locations.

c) Overall rating plate giving all relevant parameters of GIS

14.10 TRANSPORT OF EQUIPMENT TO SITE.

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. In case of electronic impact recorder, the recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

14.11 PACKING, STORAGE AND UNPACKING

14.11.1 All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

14.11.2 The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

14.11.3 Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

14.11.4 Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

14.11.5 Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.

14.11.6 Blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site which may on later stage necessarily be used during repair and maintenance shall remain the property of AEGCL. Balance blanking plates, caps, seals, etc shall be returnable to the contractor. If considered necessary, blanking

plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

14.11.7 Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipmentto site.

14.11.8 For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected.

14.11.9 The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing on raised platform, as required etc. is included in the works to be performed by the contractor. **Cost of the raised platform for temporary storage is deemed to be included in overall cost.** The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge. performed by the contractor. Cost of the raised platform for temporary storage is deemed to be included in overall cost. The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge. **The GIS components shall be stored in a single layer such that all the components can be easily accessible.**

14.11.10 The equipment shall be unpacked immediately before Installation. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen or SF6 gas until required.

14.11.11 For the purpose of release of payment linked to receipt and physical verification in case of GIS equipment it shall mean random opening and physical verification of one number of packing unit of each type of main equipment (i.e. GIS CB/ISO/ES/PT/LA/**SF6 to air bushing & cable termination module etc.)** for each voltage level. Thereafter proper re-packing of the GIS unit shall be ensured as per manufacturer recommendation.

14.12 INSTALLATION OF GIS

14.12.1 Civil works of GIS Hall shall be completed in all respects before taking up the installation and it shall be ensured that Ventilation System is operational and all dust and dirt in the hall are removed. **No dust shall enter the GIS hall after complete installation of the GIS modules. The GIS Hall needs to be maintained with positive pressure of +5mm water column before starting installation of GIS modules.**

14.12.2 The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall undertake the erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate to AEGCL.

14.12.3 Un-packaging of GIS modules shall be done outside the GIS hall and in no case module tobe taken inside GIS hall with packing.

14.12.4 **All assembly work shall be done by qualified personnel only who are to be identified and list submitted to AEGCL site before starting of erection work.**

14.12.5 Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of erection work.

14.12.6 Working personnel shall clean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non- fluffy material.

14.12.7 **All man entry door in GIS hall shall be of double door type and shall have automatic close facility after entry of personnel to avoid dust and moisture entry**. Walls and ceiling shall be in a condition so that neither dirt nor plaster might fall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.

14.12.8 Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done on regular basis. **GIS hall floor shall be anti-skid type and shall not damage due to movement of gas cart.**

14.12.9 Only T&P and consumables required for GIS erection shall be kept in GIS during erection.

14.12.10 In case of outdoor installation of GIS or of GIS components open gas compartments shall be protected from dust and moisture ingress (by tarpaulin covers/protective enclosure/chamber etc)

14.12.11 Bus duct exits in the GIS hall's wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.

14.12.12 Maintenance room (as a part of LCR room) shall be constructed for carrying out repair works/ small part assembly. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in thisroom for rework.

14.12.13 Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved by AEGCL site before start of erection. Shock recorder down loaded data and analysis shall be submitted preferably before commencement of erection work. In case of violationof shock limits, expert form manufacturer shall visit and do the joint internal inspection and shall submit analysis report before giving clearance for erection. If required the module shall be taken back to factory for further analysis and testing.

14.12.14 Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact & sealing surfaces shall be cleaned before installation. Cleaning shall be carried out with specified cleaning agents of the manufacturer, in no condition water is to be used except for external surfaces. Further, prior to opening of gas compartment, the same shall be thoroughly cleaned externally. The vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected.

14.12.15 All Civil Work inside building including internal cable trench shall be completed beforeGIS installation.

14.12.16 Installation of flanges shall be done immediately after removal of transport covers. Transport covers, O-rings and other packing material of GIS shall be taken out immediately after removal.

14.12.17 O Rings shall be properly stored and taken out only before installation. O Rings are also tobe cleaned before use with manufacturer authorized cleaning agent.

14.12.18 At all points of time during installation authorized personnel shall use suitable gloves to avoid contamination.

14.12.19 Cable termination work shall commence only after completion of GIS equipment erection,as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.

14.12.20 Approved Field Quality Plan shall be followed during site work.

14.13 ON SITE TESTING

After the GIS Switchgear has been fully installed at site and SF6 gas filled at rated filling density, the complete assembly shall be subjected to the site tests as per IEC-62271-203 Method statement/ procedure of ON SITE high voltage testing, PD measurement and Switching Impulse test shall be submitted by contractor in advance.

(A) Commissioning Tests/On Site Tests After Erection:

After erection, and before putting into service, the gas-insulated metal enclosed Switchgear shall be tested for the correct operation and dielectric strength of the equipment.

These tests and verifications shall comprise:

(1) Tests to be conducted on the circuit breaker at site at all required operating sequences Measurement of operating time, Checking of wiring and connections and dielectric checks Indications, alarms and interlocks, auxiliary contacts Operation at minimum and maximum control supply voltage/pressure Operation of anti-pumping device.

(2) Test to be conducted on the Disconnectors at site Checking of wiring and connections and dielectri checks Indications, alarms and interlocks, auxiliary contacts Operation at minimum and maximum control supply voltage/pressure

(3) Other Tests at Site: Dielectric tests on auxiliary circuits, Measurement of the resistance of the main circuit Measurement of gas condition, Gas tightness tests General verifications Tests as per IEEE C37.122.1 clause 4.10.5 Demonstration of operationalcompatibility with SCADA Mechanical operation tests of circuit breakers Disconnectors and earthing switches and high-speed earthing switches Insulation resistance measurement. Calibration of all the measuring equipment shall be checked before energization of the GIS.

(B) Power Frequency Test: On Site Testing of GIS Power frequency tests for the completed GIS at site shall be complied as per IEC 60270. Power frequency tests for the completed GIS at site shall be possible without removing the voltage transformers. The power frequency test voltage at site shall be 80% of the factory test voltage for 1 min at 100Hz.The Supplier is responsible to furnish the test equipment for conducting following performance tests at site. Voltage tests on main circuits at reduced voltage (80% p.f.) comprising:

50 Hz A.C. voltage test for 1 min

Partial Discharge test

The manufacturer shall provide:

-The test voltage source.

-All connections between the switchgear and the test voltage source.

The procedure to be implemented following a discharge during dielectric tests is as follows:

if a disruptive discharge occurs at the first test while increasing of test voltage, a second test is performed.

If a second disruptive discharge occurs in the same compartment before reaching the highest level, there are two possibilities:

- If the second disruptive discharge is higher than the first voltage again the voltage is immediately increased. If a new discharge occurs the value of which is again higher, a new test will be carried out.
- If the second disruptive discharge is lower than or equal to the first, the test is stopped and the compartmentdismantled.

The process is continued in order to reach the test voltage. If a disruptive discharge occurs at this voltage, there are two possibilities:

- if it is the first disruptive discharge in the compartment since the test was begun, voltage is again increased. If there is no other discharge, the test has been successful. The test is stopped and the compartment dismantled.

- if some discharge has previously occurred in this compartment during the increase in voltage, the test is stopped and the compartment dismantled.

Required test equipment

During the on site tests, the supplier shall provide all necessary test facilities and equipment (such as high voltage test kit) for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc. based on the voltage level of the GIS on returnable basis. For installation of HV test bushing suitable space shall be kept near to GIS. Cable termination chamber shall have suitable adapter arrangement to inject the HV test probe.

6.14. MANDATORY SPARS: Design, engineering, manufacture, testing, supply on FOR destination site basis including transportation & insurance, storage at site of Mandatory spares for the GIS. Standard list of Mandatory Spares **shall be provided as per the BPS.**

16.15 SAFETY:

To ensure safety of personnel during maintenance, the GIS and switch room shall be arranged to facilitate safe and direct personnel access to all locations as follows:

1. Electrical and mechanical points of control of the GIS (disconnectors, earthing switches and circuit breaker mechanical trip mechanism)
2. Mechanical position indication of circuit breakers
3. Mechanical position indicators of disconnectors and earth switches
4. Inspection windows to verify position of disconnectors and earth switches
5. Gas density monitors, pressure transducers and filling points
6. Circuit breaker spring status mechanical indication
7. Current transformer secondary connection terminal boxes
8. Voltage transformer secondary connection terminal boxes
9. Already fitted PD monitors

Where the layout consists of two or more bays coupled to each other via the busbar, the busbar shall incorporate an additional buffer or spacer compartment to allow movement of personnel in between the bays to access any components located to the side of bays to carry out the activities 1 to 8 as listed above.

The additional buffer compartment shall be provided where the proposed equipment does not provide an access route between the bays. The buffer or spacer compartment shall be suitably sized such that a minimum of 1000 mm width spacing is provided between bays to allow access and movement of persons carrying out operations, regular inspection and maintenance tasks. Where the Customer proposes to supply free standing LCC's, the cabinets shall be free standing positioned over a cable ope or floor opening to accept the low voltage control cabling. The cabinet shall be swing frame type with door opening outwards to the left-hand side. All points of control shall be located on the front of the cabinet to allow operation and inspection without stepping inside the cabinet. The interior of the cabinet shall be equipped with a light. Removable gland plates shall be labelled with permanent stickers identifying the Safe Working Load (SWL) that the plate may bear. Adequate safety screens shall be provided for all moving parts. Provision shall be made for carrying out primary injection tests on all current and voltage transformers without requiring internal access to any gas compartment. The HV cable screen termination box in the HV cable room should be accessible from ground level.

14.14 TESTING & MAINTENACE EQUIPMENT

16.16.7 Special Tools

Any special tools needed for installation, operation and inspection shall be included in the quotation.
These special tools shall be supplied along with the GIS and shall not be taken back by the Tenderer. For gas handling purpose following tools shall be quoted as a minimum:

a) SF6 Gas Processing, Drying, Storage & Filling Unit
b) Online Partial Discharge Monitoring Unit
c) SF6 gas quality testing unit SF6 Gas Leak Detector
d) Precision Pressure Gauge with red & green zone marking.
e) SF6 Gas Evacuation Plant (One mobile cart and one static cart)
f) Video Borescope

Testing & Maintenance equipment shall be offered, as per BoQ.

16.16.8 SF6 Gas Leakage Detector.

The detector shall be portable, battery operated, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The detector shall be lightweight, cordless unit able to detect SF6 leaks in seven different sensitivity levels with a response rate of one second. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The test kit shall be compatible for EMI/EMC environment as per IEC 1000. **The leakage data shall be clearly presented on an LED display. The detector should be temperature compensated**.

16.16.9 Gas filling and evacuating plant : (Gas Processing unit)

- The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).
- Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.
- The minimum capacity parameters of evacuation plant shall be as under :

  Oil Free Suction (Recovery) Pump: 30 M^3/Hour
  Compressor (Two Stage): 15 M^3/Hour
  Oil Free Vacuum Pump: 100 M^3/Hour
- The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.

Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished.

- The service cart shall be designed for emission free gas handling with the couplings. Touch screen facility shall be present. Indication units such as bar/mbar, kPa or psi/torr etc. shall be selectable in the touch screen.

16.16.10 SF6 Gas Analyzer:

a. In-built calibration facility.
b. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.
c. Equipment shall work on zero gas loss principle i.e. gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.
d. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.
e. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376
i) SF6 purity – Range: 0-100 % & Accuracy: +/- 2 deg C
ii) Dew point - Range : -60 to +20 deg C & Accuracy: +/- 2 deg C (to> -40 deg C); +/- 3 deg C (to<-40 deg C)
iii) SO2 - Range : 0-150 ppm & Accuracy : +/- 2 %
iv) HF - Range : 0-10ppm & Accuracy : +/- 10 %
f. Instrument should work on AC source as well as on rechargeable battery without causing any data loss. Also, provision for downloading the data shall be provided.
g. Input pressure: upto 10 bar
h. It should be housed in a robust IP67 case with wheels
i. User Interface: USB/LAN/Wifi
j. Data storage: Minimum 1000 measurement values shall be stored
k. Sensor modules should be field exchangeable.
l. Battery must be easy to exchange (max 5 min duration)

16.16.11 Online Partial Discharge Monitoring System

- GIS equipment shall be designed so as to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.
- An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers and SF6 to Air bushing and cable termination module adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.

- On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection.
- The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble free online PD monitoring of complete GIS

installation shall be considered as included in the scope.

- The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.

- The integration of UHF PD coupler in future GIS bays shall be done in respective package. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).

- The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer, and spare slots for hot-pluggable hard disks to extend the storage capacity. The workstation PC and all equipment & cabinets shall be powered by suitable dedicated UPS of adequate rating and same is included in the present scope.

- Design of on-line PDM System

  1. The technical proposal for PDM system along with detailed design documentation shall be submitted for EMPLOYER'S approval during engineering stage.
  2. To guarantee that sufficient coverage is available for complete GIS installation to monitor PD activity all design details shall be submitted as part of the above for review.
  3. The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.
  4. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
  5. The signal attenuation level of co-axial cable per meter length and justification forthe length of cable connection between the couplers and detector units shall be furnished.
  6. The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.
  7. The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc. shall be submitted during engineering stage for approval.
  8. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labeling and indicated in the substation PDM SLD.
  9. Internal arrangement/wiring diagram is to be submitted for detector units/control cabinet etc. All internal items are to be identified / labeled to facilitate troubleshooting.
  10. Supply requirement (AC & DC) to be specified for the complete monitoring system.
  11. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. Ratings of UPS shall be proposed for the approval of EMPLOYER'S. The UPS shall have enough capacity to initiate a 'safe' shut down of the PDM PC and the peripherals after this 15-minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication / alarm when it requires battery replacement. Potential Free Contacts shall be generated to signal these events. These contacts shall be wired out to Annunciation / Monitoring systems. Alternately, inverter of suitable capacity is also acceptable. Critical Process and Status alarms of the PDM system shall be displayed.
  12. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be

defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc. To guarantee a proper synchronization at all time, there shall be a minimum of 4 synchronization-inputs and the PDMS shall provide a facility to automatically select one of the active synchronization signals. The control software shall be able to generate the all the logs related to system fault (including skipped MCBs, overvoltage protection, faultycommunication and the connection to each frequency converter unit)

13. Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS should be furnished.
14. The selected mode of propagation of PD signal (electromagnetic wave) inside GISfor the design of sensors shall be furnished.
15. The protection available for electronics against transient over voltages caused byswitching operations shall be furnished.
16. The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.
17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation has to be submitted in this regard.
18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.
19. A redundant fibre optic ring network shall transmit the measurement data from all acquisition units to the PDMS control cabinet. The communication between the acquisition units and the server/control cabinet shall be TLS encrypted.

- **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

- **Every Day Use & Maintenance** : The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminatingthe necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

- **Computers and Peripherals: Computers and Peripherals: The PC operating system shall be the latest version of MS Windows/LINUX**. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available inthe market of industrial type subject to EMPLOYER'S / Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. ThePC monitor shall be 21" LCD type of reputed make.

- **Filtering Facility:** The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor

use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.

- **Self-Test (Diagnostic) Facility**: Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.
- **Detector Units:** The sensitivity of each detector unit shall be furnished. The sensitivity level of individual detector units shall be selectable depending on the site background noise level.
- **Trend Plot:** The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.
- **PD Monitoring modes**: There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day today operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature.

  In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.
- **Alarm Facility:** The PDM system shall generate alarm when action is required; viz. a) PD alarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.
- **Real Time Display:** The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second-update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.
- **Schematics: The** PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.
- **Print Option/Facility:** PDM system should have the option/facility of printing all trend plots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.
- **Data Archives:** This is to provide access to historical data and file storage with date and time stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.
- **PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance**

Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shallalso make available typical point-on-wave patters as library pictures to train the user.

Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.

- **Fault investigation**: In case of any indication of suspected PD activity by the on line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period
- **Special Tools / equipment, Spare Parts, software packages**
- **Special Tools:** Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.
- **Spare parts:** The contractor has to supply critical spares with replacement procedure for the trouble-free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.
- **Software Packages:** The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.

  Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.
- **Operation & Maintenance Manual**: A complete O&M manual covering all aspects of trouble shooting of PDM system in six sets in original shall be provided & also in CD's. For diagram references colour pictures shall be provided. A step-by-step procedure for spare parts replacement shall also be included.
- **Factory / Site Test Formats**: The factory & site tests format to be submitted for approval. The format shall cover all possible tests to confirm healthiness of the system and to record the test values.
- **List of References**: List of References: The bidder shall provide a reference list of PD monitoring system having field proven experience of the offered model, which is supplied by them and in successful operation worldwide in a power utility for at least 5 years.
  "The OEM should be having more than 20 years of experience in working with UHF based technology of PD monitoring and at least 10 years of experience in selling UHF based PD monitoring products to various electric utilities .The OEM must have supplied at least 5 (five) Online UHF PD monitoring system to different power utilities in India in last 10 (ten) years for the GIS ratings 400kV and above. The OEM must have their own direct established service Centre in India with certified on–roll service engineers equipped with proper tools & tackles to response to any sort of service issues locally, for which documentary evidence like service order copy/AMC copy released by Government utility/PSUs in the last 5 years, which should be on the name of OEM, shall be submitted along with the bid. They must have local on-roll experts to provide the technical support time to time."

Video Borescope:

- LCD: 16.25 cm (6.4 in) diagonal active-matrix VGA color LCD
- Display Resolution: 640 x 480px
- Sunlight Readable: 1100 Cd/Msquared
- Mounting: 75 x 75 mm (1/4-20) and vesa mount
- Battery Life (continuous): 6 to 8hrs (integrated), 3600 mAh rechargeable battery
- Frame Rate: 30fps (NTSC & PAL)

- Video / Image Transfer: SD Card or USB
- Camera Diameter Range: 25mm
- Camera Focal Length Options: Long View and Short View Macro
- Camera Length Range: 30m
- Video resolution: 960x480 (avi format) (with sound)
- Image Resolution: 640x480 (jpeg format)
- Memory: Internal 4GB, 16 GB SD card (expandable to 32 GB)
- Transmission frequency: 2.4GHz
- Transmission Range: 32ft (10m) unobstructed view
- Viewing direction: Viewing angle 110 degree
- Power: AC: 90-264 Vac, 47-63HZ, <1.2 A rms @90Vac
- DC: 10.2V +5/-3%. 4.9A
- Tip Operating Temp: -25°C to 100°C (-13°F to 212°F) Reduced articulation below 0°C (32°F)
- System Operating Temp: -20°C to 46°C (-4°F to 115°F)
- Storage Temperature: -25°C to 60°C (-13°F to 140°F)
- Relative Humidity: 95% max, non-condensing
- Waterproof: Insertion tube and tip to 14.7 psi (1 bar, 10.2m of H2O, 33.5 ft of H2O)
- Ingress Protection: IP67
- Joystick Control: 360° All-Way® tip articulation, bump gesture, menu access and navigation
- Button Set: Access user functions, measurement and digital functions
- Audio: Integrated 2.5mm headset/microphone jack
- Data I/O Ports: Two USB 2.0 ports
- Brightness Control: Auto and Variable
- Illumination Type: White LED
- Long Exposure: Via auto and manual mode
- White Balance: Factory default or user defined
- Operating System: Real-time multi-tasking operating system
- User Interface: Simple drop-down menu-driven operation Menu navigation using articulation joystick
- File Manager: Embedded file manager software supporting: File & Folder creation, naming, deleting, Store to internal Flash (C:\) or USB Thumb Drive Copy between USB and C:\
- MDI Software : Provides user defined guided inspection, Creates DICONDE compatible inspection files, Creates MS Word™ compatible inspection reports.
- It shall be electrostatic and electromagnetic interference proof.
- Audio Data: PC compatible (.mp3) file format
- Image Control: Invert, Zoom (5X digital) Image Capture and Recall
- Digital Zoom: Continuous (5.0X)
- Image Formats: Bitmap (.BMP), JPEG (.JPG)
- Video Format: AVI
- Text Annotation: Built-in full screen text overlay generator, 100 text line capacity
- Graphic Annotation: User placement of arrows
- Articulation Control: “Steer & Stay” articulation lock/fine articulation
- Tip “Home” return to neutral forward-tip orientation
- User-selectable fine or coarse control XpertSteer probe articulation offers quick steering responsiveness for tight probe control bump steering enables slight adjustments to probe position
- Software Updates: Field updateable via USB Thumb Drive
- Languages: English
- Boost function improved image quality in dark environments
- Illumination: 12 white LEDs

TRAINING:

The successful bidder shall organize a 15 (official) days training program at GIS manufacturer's end for 10 numbers of AEGCL engineers **at free of cost** making understand all the key points related to the design of GIS and shall also highlight the maintenance issues related to GIS and steps to tackle them. The GIS manufacturer shall provide a detailed training to the AEGCL engineers. Further, the successful bidder shall organize an on-site GIS training program also for 10 (official) days for 20 AEGCL engineers **at free of cost** where the GIS manufacturer will provide necessary training for on-site testing and all other key points related to GIS erection, operation and maintenance.

The successful bidder shall also organize an on-site training program for 7 (official) days for 20 numbers of AEGCL engineers at free of cost for GIS handling and maintenance equipment for familiarizing the handling equipments with the AEGCL engineers. The manufacturer of each GIS maintenance equipment (as mentioned in the BoQ) shall provide necessary training regarding operation and maintenance of the gas handling and other equipments

GTP of GIS CIRCUIT BREAKER

Sl.No.	Parameter	400kV system	220kV system	132 kV system
1.	Rated voltage (Umax) kV (rms)	420	245	145
2.	Rated frequency (Hz)	50	50	50
3.	No. of poles	3	3	3
4.	Type of circuit breaker	SF6 gas insulated	SF6 gas insulated	SF6 gas Insulated
5.	Rated continuous current (A) at an ambient temperature of 50^0C	4000	3150	3150
6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening time under operating conditions specified.	63kA	50 kA	40kA
7.	Symmetrical interruptingcapability kA (rms)	63kA	50kA	40kA
8.	Rated short circuit makingcurrent kAp	157.5	125	100
9.	Short time current carrying capability kA (rms)	63kA for 3 sec	50kA for 3 sec	40kA for 3 sec
10.	Out of phase breaking currentcarrying capability kA (rms)	15.75	**As per IEC**	**As per IEC**
11.	Rated line charging interrupting current at 90 deg. Leading powerfactor angle (A rms) (The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/□3 and 1.4 as per IEC-62271-100	600	As per IEC	As per IEC

12.	First pole to clear factor	1.3	1.3	1.3
13.	Temperature rise over an ambient temperature of 50^0C	As perIEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100
14.	Rated break time as IEC (ms)	40	60	60
15.	Total break time (ms)	45	65	65
16.	Total closing time (ms)	Not more than 80	Not more than **100**	Not more than **100**
17.	Operating mechanism or a combination of these	Spring	Spring	Spring
18.	Rated operating duty cycle	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO
19.	Reclosing	Single phase &Three phase autoreclosing.	Single phase &Three phase auto reclosing.	Three phase auto reclosing. (Single phase auto reclosing if specified in section-project)
20.	Pre-insertion resistor requirement	As per BPS	NA	NA
i)	Rating (ohms)	400(max.)with tolerance as applicable	NA	NA
ii)	Minimum electrical (mechanical insertion time +pre-arcing time) pre-insertion time (ms)	8	NA	NA

21.	Max. difference in the instants ofclosing/opening of contacts (ms) between poles at rated control voltage and rated operating & quenching media pressures	2.5(within a pole) 3.3(opening) 5.0(closing)	3.3(opening) 5.0(closing)	3.3(opening) 3.3(closing)
22.	Maximum allowable switching over voltage under any switching Condition	2.3 p.u.	As per IEC	As per IEC
23.	Trip coil and closing coil voltagewith variation as specified	220V DC	220V DC	220V DC or 110V DC
24.	Noise level at base and up to 50 m distance from base of circuit breaker	140dB (max.)	100dB (max.)	80dB (max.)
25.	Rating of Auxiliary contacts	10A at 220V DC	10A at 220V DC	10A at 220V DC
26.	Breaking capacity of Aux.Contacts	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms
27.	**Rated insulation levels**			
i)	Full wave impulse withstand(1.2 /50 μs) between line terminals and ground	1425 kVp	1050 kVp	650 kVp
ii)	Full wave impulse withstand(1.2 /50 μs) between terminals with circuit breaker open	1425 kVp impulseon one terminal& 240	1050 kVp	+ 650kVp
		kVp power frequency voltage of opposite polarity on the other terminal		
iii)	Rated switching impulse withstand voltage (250/2500 μs) Dry & wet between line terminals andground	+1050 kVp .	NA	NA

iv)	Rated switching impulsewithstand voltage (250/2500 µs) Dry &wet Between terminals with circuit breaker open	900 kVp impulse on one terminal& 345 kVp power frequency voltage of opposite polarity on the other terminal	NA	NA
v)	One minute power frequency drywithstand voltage between line terminals and ground	520 kV rms.	460 kV rms.	275 kV rms
vi)	One minute power frequency drywithstand voltage between terminals with circuit breaker open	650 kV rms.	460 kV rms.	275 kV rms
28.	Minimum corona extinction voltage with CB in all positions	320kV rms	156 kV rms	92 kV rms
29.	Max. radio interference voltage for frequency between 0.5 MHzand 2 MHz (Micro volts)	1000 µV (at 266kVrms)	1000 µV (at 156kV rms)	500µV (at 92kV rms)
30.	System neutral earthing	Effectively earthed		
31.	Auxiliary contacts	Besides requirement of technical specification, the manufacturer/contractor shall wire up 10 NO +10 NC contacts exclusively for purchaser's use and wired up to common marshalling box. (LCC)		
32.	No. of terminals	All contacts & control circuits to be wired out up to common marshalling box + minimum 24 terminals exclusively for purchaser's future use		

GTP of GIS DISCONNECTORE/ISOLATORS

Sl. No	Particulars	400 kV	220 kV	132kV
1.	Rated voltage (rms)Un	420 kV	245 kV	145 kV
2.	Rated frequency	50 HZ	50 HZ	50 Hz
3.	System earthing	Effectively earthed	Effectively earthed	Effectivelyearthed
4.	Type	SF6 insulated	SF6 insulated	SF6 insulated
5.	Rated continuous current (A) at 50^0C ambient temp.(as applicable)	4000	3150	3150
6.	Rated short time withstand current of isolator and earth switch(as applicable)	63 kA for 3 Sec.	50kA for 3 Sec.	40 kA for 3 second
7.	Rated dynamic short circuit withstand current withstand current of isolator and earth switch(As applicable)	157.5 kAp	125 kAp.(As applicable)	100 kAp
8.	Rate insulation d level:			
	One minute power freq. Withstand voltage: To earth :	650 kV rms.	460 kV rms.	275 kV rms.
	One minute powerfreq. Withstan d	815 kV rms.	530 kV rms.	315 kV rms.

	voltage: Across isolating distance			
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity) To earth:	1425 kVp	±1050 kVp	650kVp
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity) : Across Isolating distance	±1425/-+240 kVp	1200 kVp	As per IEC
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet :between line terminals and ground:	+/- 1050 kVp	N.A	N.A
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet :Between terminals with Isolator open:	+/- 900 kVp impulse on one terminal & 345 kVp of opposite polarity on the other terminal.	N.A	N.A
9.	Mechanical Endurance as per IEC clause	M2	M2	M2
10.	No. of spare auxiliary contacts on each isolator	4 NO and 4 NC	4 NO and 4 NC	4 NO and 4 NC
11.	No. of spare auxiliary contacts on each earthing switch	4 NO and 4 NC	4 NO and 4 NC	4 NO and 4 NC

GTP OF GROUNDING SWITCHES					
SL. NO	SYSTEM PARAMETERS	UNIT	RATING		
			400	**220**	132
I	**II**	**III**	**IV**	**V**	VI
1	Rated Voltage	Kv	420	245kV	145
2	Lightning impulsewithstand voltage against ground	kV	1425	1050	650
3	Lightning impulse withstand voltage across isolating distance	kV	Lightning Impulse: As per IEC 62271-203		
4	Power frequency withstand voltage against ground	kV	650	460	275
5	Power frequency withstand voltageacross isolating distance	Kv	Power frequency: As per IEC 62271-203		
6	Nominal operating current	A	4000	3150	3150
8	Number of poles		3		
9	Dynamic current	kA	157.5	125	100
12	Rated short-circuitwithstand current (r.m.s.), 3s	kA	63	50	40
13	Type of operating mechanism		Motor operation		
14	Number of drives per3 phase		1		
15	Control voltage (DC)	V	220 DC		
16	Number of CO operations permissiblewithout maintenance	No.	As per latest IEC standard		

HIGH SPEED EARTH SWITCH					
SL.NO	SYSTEM PARAMETERS	UNIT	RATING		
			400	220	132
I	II	III	IV	V	VI
1	Rated Voltage	kV	420	245	145
2	Lightning impulse withstand voltage against ground	kV	1425	1050	650
3	Lightning impulse withstand voltage across isolating distance	kV	Lightning Impulse: As per IEC 62271-203		
4	Power frequency withstand voltage against ground	kV	650	460	275
5	Power frequency withstand voltageacross isolating distance	Kv	Power frequency: As per IEC 62271-203		
6	Nominal operating current	A	4000	3150	3150
7	Inductive curre ntswitching capability	A , kV	As per IE C standard		
8	Capacitive curre ntswitching capability	A , kV	As per IEC standard		
9	Number of poles		3		
10	Dynamic current	kA	157.5	125	100
11	Rated short-circuitwithstand current (r.m.s.),	kA	63	50	40

	3s				
12	Type of operating mechanism		Motor operation		
13	Number of drives per3 phase		1		
14	Control voltage (DC)	V	220 DC		
15	Short-circuit making:	Class	E1		
16	Number of CO permissible without maintenance	No.	As per latest IEC standard		

CURRENT TRANSFORMERS

S. No.	Description	765kV System (NA)	400kV system	220kV system	132 kV system
1	Rated voltage, U_m (kVrms)	800	420	245	145
2	Rated frequency (Hz)	50	50	50	50
3	No. of Poles	1	1	1	1
4	Design ambient temperature(°C)	50	50	50	50
5	Rated Primary Current (A)	3000	As per schedule of requirement		
6	Rated extended primarycurrent	120%	120%	120%/150 %	120%/150%
7	Rated short time thermalwithstand current	50kAfor 1 sec	63k A for 3 sec	50kAfor 3 sec	40 kA for 3 sec
8	Rated dynamic current	125kAp	157.5kAp	125kAp	100kAp
9	Temperature rise over designambient temperature	As per IEC			
10	Rated Insulation levels				
a)	Full wave impulse withstand voltage (1.2/50 microsecond)				

S. No.	Description	765kV System (NA)	400kV system	220kV system	132 kV system
i)	between line terminals andground(kVpeak)	±2100	±1425	±1050	±650
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)				
i)	between line terminals andground (kVpeak)	± 1550	± 1050	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)				
i)	between line terminals andground (kVrms)	975 (dry only)	650 (dry only)	460	275
d)	One minute power frequencywithstand voltage between secondary terminals & earth (kVrms)	5kV			
11	Max. radio interference voltage for frequency between0.5 MHz and 2 MHz	2500 at 508 kV rms	1000 at 266kV rms	1000 at 156kV rms	500 at 92kV rms
	at (microvolts)				
12	Minimum Corona extinction voltage (kVrms)	508	320	-NA-	-NA-
13	Seismic acceleration (Horizontal)	As per Zone-V			
14	Partial Discharge	As per IEC	As per IEC	As per IEC	As per IEC
15	Number of terminals	All terminals of control circuits are to be wired up to marshaling box plus 20% spare terminals evenly distributed on all TBs.			
16	System Neutral earthing	Effectively earthed			
17	Ratio and Accuracy class	As per project Reaquirement			

TECHNICAL PARAMETERS FOR VOLTAGE TRANSFORMERS

S. No.	Description	765kV System (NA)	400kV system	220kV system	132 kV system

1	Type (CVT/IVT)	**CVT**	**CVT/IVT**	**CVT/IVT**	**CVT/IVT**
2	Rated voltage, U_m (kVrms)	800	420	245	145
3	Rated frequency (Hz)	50	50	50	50
4	No. of Poles	1	1	1	1
5	Design ambient temperature(°C)	50	50	50	50
6	System fault level (kA)	50kA for 1sec	63kA for 3 sec	50kA fo 3sec	40 kA for 3sec
7	Standard reference range offrequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement			
7	High frequency capacitance forentire carrier frequency range (for CVT only)	Within 80% to 150% of rated capacitance			
8	Equivalent series resistance over entire carrier frequencyrange (for CVT)	Less than 40 Ohms			
9	Stray capacitance and stray conductance of HF terminal over entire carrier frequency range (for CVT)	As per IEC-60358			
10	Temperature rise over designambient temperature	As per IEC			
11	Rated Insulation levels				
a)	Full wave impulse withstand voltage (1.2/50 microsecond)				
i)	between line terminals andground (kVpeak)	±2100	±1425	±1050	±650
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)				
i)	between line terminals andground (kVpeak)	± 1550	± 1050	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)				
i)	between line terminals andground (kVrms)	975 (dry only)	650 (dry only)	460	275
d)	One minute power frequency withstand voltage between secondary terminals & earth				
i)	between LV (HF) terminal andearth terminal (kVrms)	10kVrms for exposed terminals and 4kVrms for terminals enclosed ina weather proof box			
ii)	For secondary winding	3kVrms			

11	Max. radio interference voltage for frequency between0.5 MHz and 2 MHz at (microvolts)	2500 at 508 kV rms	1000 at 266kV rms	1000 at 156kV rms	500 at 92kV rms
12	Minimum Corona extinction voltage (kVrms)	508	320	-NA-	-NA-
13	Partial Discharge	As per IEC	As per IEC	As per IEC	As per IEC
14	Number of terminals	All terminals of control circuits are to be wired up to marshaling box (LCC) plus 20% spare terminals evenly distributed on all TBs.			
15	Rated Total Thermal Burden(VA)	300 VA (100VA/winding)			
17	System neutral earthing	Effectively Earthed			

TECHNICAL PARAMETERS OF GIS SURGE ARRESTOR

Sl. No.	Description	Unit	800kV SA (NA)	420kV SA	245kV SA	145kV SA
1	Nominal Syste mOperating voltage	kV, rms	765	400	220	132
2	Rated frequency	Hz	50	50	50	50
3	No. of Poles	No.	1	1	1	1
4	Design ambient temperature	°C	50	50	50	50
5	Rated arrester voltage	kV	624	336	216	120
6	Continuous operating voltage at 50 deg.C	kV	490	267	168	102
7	Nominal dischargecurrent		20 kA of 8/20 microsecon d wave	20 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave
8	Discharge current at which insulationco-ordination will be done		20 kA of 8/20 microsecon d wave	20 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave

Sl. No.	Description	Unit	800kV SA (NA)	420kV SA	245kV SA	145kV SA
9	Minimum discharge capability (referredto rated arrester Voltage) or corresponding to minimum discharge voltage as per clause-2.0 (d) whichever is higher	kJ/kV	13kJ/kV	12kJ/kV	9kJ/kV	8kJ/kV
10	Max. switching surge residual voltage	kVp	1180 (at 1kA) 1220 (at 2kA)	670(at 2kA) 650 (at 500A)	500 (at 1kA)	280 (at 1kA)
11	Max. residual voltage at					
i)	5kA	kVp	-	-	560	310
ii)	10 kA nominal discharge current	kVp	-	800	600	330
iii)	20 kA nominal discharge current	kVp	1480	850	-	-
iv)	Steep fronted waveresidual voltage at 20 kA	kVp	1480	925	-	-
12	Long duration discharge class		5	4	3	3
13	High current shortduration test value(4/10 micro second wave)	kAp	100	100	100	100
14	Current for pressure relief test	kA rms	63	63	50	40
15	Low current long duration test value					

Sl. No.	Description	Unit	800kV SA (NA)	420kV SA	245kV SA	145kV SA
16	Insulation Level					
a)	Full wave impulse withstand voltage (1.2/50 microsec.)					
i)	Arrester Housing	kVpeak	As per IEC:60099-4	±1425	±1050	±650
b)	Switching impulse withstand voltage (250/2500 micro-second) dry and wet					
i)	Arrester Housing	kV peak	As per IEC:60099-4	± 1050	-NA-	-NA-
c)	One minute power frequency dry withstand voltage					
i)	Arrester Housing	kV rms	830	650	460	275
18	Partial Dischargeat 1.05 COV		≤ 10pC	≤ 10pC	≤ 10pC	≤ 10pC
19	System neutral earthing		Effectively Earthed	Effectively Earthed	Effectively Earthed	Effectively Earthed

TECHNICAL PARAMETERS FOR SF6/AIR BUSHING

Sl. No.	Particular	765 Kv (NA)	400 kV	220 kV	132kV
1	Rated Voltage (kV)	800 kV(rms)	420 kV (rms)	245 kV (rms)	145 kV (rms)
2	Rated Current (Amp)	2000/3150 as applicable	4000	3150	2500
3	1.2/50 micro second impulsevoltage (Lightning impulse withstand voltage)	2100 kVp	1425 kVp	1050 kVp	650 kVp
4	250/2500 micro second switching impulse voltage	1550 kVp	1050 kVp	-	

5	One minute power frequency withstand voltage	960 kV (rms)	650 kV (rms)	460 kV rms	275 kV (rms)
6	Minimum total Creepage distance in mm	31mm/kV	31mm/kV	31mm/kV	31mm/kV
7	Minimum Cantilever strength (kN)	10	10	8	8