

BIDDING DOCUMENT FOR

**“Turnkey Construction of 1 (one) no. of 132/33kV, 50MVA Transformer Bay
(both LV & HV) along with related services at 132kV Baghjap GSS of
AEGCL.”**

FUND: “Term Loan from Punjab & Sind Bank”



(E-Tender)

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VOLUME-2 TECHNICAL SPECIFICATION

BID IDENTIFICATION NO:

AEGCL/MD/Tech-33/BD/TR. Bay/Baghjap/2026/BID, Dated: 10.09.2026

**Assam Electricity Grid Corporation
Limited**

Tender Fee - Rs.1000/-

VOLUME-2 TECHNICAL SPECIFICATION

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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 33kV & 132kV 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 including substation steel structures and civil foundations for equipment as specified in subsequent Clauses and Sections.
- 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 transformer pad, 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 33kV & 132kV bays under construction vide this BID) etc. as brought out in the Specification and Schedule of Requirements.
 - vi) Integration of all switch & control gears of the bay including control and relay panel along with the ABT metering module into the existing Substation Automation System at 132kV Baghjap GSS.
- 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 believed.

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 SERVICECONDITIONS

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	Below 1000 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 authorized 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 CDs.
- 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 Contractor's 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 drawings supplied with this bidding document.
- 2.1.3** *The above sets of drawings are tentative and may require modifications depending upon site conditions, exact equipment dimensions etc. The Contractor shall be required to prepare his own drawings based on drawings supplied, 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** Site preparation by excavation of soil and rock by mechanical means (non explosive method) upto FGL. The excavated soil and rock shall be disposed off by the contractor at their own cost and arrangement outside the AEGCL campus. All permission, royalty or any legal obligation has to be borne by the contractor. Any damage cause during execution shall be liability of the contractor.
- 2.2.2** Before taking up PCC base (pro1:3:6) 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.
- 2.2.3** 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.
- 2.2.4** A base layer of PCC of 80 mm thickness with proportion of 1:3:6 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.
- 2.2.5** Over the PCC layer, a surface course of minimum 100mm thickness of 20mm nominal size river pebbles or (single size ungraded) broken stone shall bespread.

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 $2T/m^2$.
- 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 2mm.
- 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 galvanizing (Acceptance Test)
The test shall be done as per approved standards.
 - b. Deflection Test: (Type Test)
A 2.5-meter 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 (1:3:6) 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 40mm.

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.

a) 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 lattice.

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	$23 \times 10^{-6} / ^\circ\text{C}$	$19.35 \times 10^{-6} / ^\circ\text{C}$	$19.35 \times 10^{-6} / ^\circ\text{C}$
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 mm ²	428.90 mm ²	212.10 mm ²
9	Total sectional area	597.00 mm ²	484.50 mm ²	261.50 mm ²
10	Calculated D.C. resistance at 20°C	0.05552 ohm/km	0.06869 ohm/km	0.1400 ohm/km
11	Ultimate tensile strength	161.2 kN	130.32 kN	89.67

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

- Earthing system shall be installed as per drawings provided with this bidding document.
- The main earthing system for the switch yard shall consist of a mesh made out of

- Galvanized MS flats of size not less than 65 mm in width and 12 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 (Galvanized MS flats) in both directions perpendicularly. The mesh points so created and all other joints shall be welded 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 : 3.66mm
 - c) Minimum Breaking Load : 6970KG
 - d) Overall Diameter : 10.98mm
 - e) Area : 72.25mm²

2.11.0 BAY MARSHALLING KIOSK

- 2.11.1** **1(One)** number of bays marshalling **kiosk** shall be **provided for each 132 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 IP55.

- 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 stainless steel.
- 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 tension strings.
- 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) Electromechanical Strength : 70 KN

- i) Power frequency withstands 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 overvoltage.

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

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

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

For Connecting ACSR : Aluminium alloy casting conforming to designation A 6 of IS 617.

For Connecting Equipment : Bimetallic connectors made from aluminium alloy casting conforming to designation A 6 of IS617.

Made of Copper : Malleable Iron Casting.

For Connecting G.I Shield Wire : Copper lamination to grade FRTP-2 of IS 191.

Expansion Connectors : Hot dip galvanised mild steel.

Bolts, nuts, plain washers : Hot dip galvanised mild steel.

And spring washers for items (i), (ii) and (iii)

2.14.0 ILLUMINATIONSYSTEM

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 PAINTING

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)				
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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 CONSTRUCTION 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 OPC 43 or PPC, 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 month in

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 rods and structural steel, etc. from primary steel producer TATA, SAIL, Jindal, RINL, SHYAM of grade 500 SD or higher, 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 CONSTRUCTION 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 seaworthiness.

2.18.4 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming 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 FABRICATION OF SUBSTATION STEEL STRUCTURES

3.10 SCOPE

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

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 IS 12427 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 B of 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 terminatelines):

(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 /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 mm ²	428.90 mm ²	212.10 mm ²
9	Total sectional area	597.00 mm ²	484.50 mm ²	261.50 mm ²
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 switchyards.

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

a. 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.

b. 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 be preferred. The punching may be adopted for thickness up to 16mm. Tolerances regarding punch holes are as follows:

- Holes must be perfectly circular and no tolerances in this respect are permissible.
- 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.
- 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 610 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 galvanized 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 earthing, 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 12 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 earthing strip.

3.9.0 TEST AND TEST CERTIFICATE

- 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 comply 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 breakers shall be capable of switching transformer-magnetizing currents and shall be free from restriking.
- 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 at least 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 Datasheet.
- 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 minimize 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 Sf₆ gas decomposition products.
- 4.5.5 Each pole shall form an enclosure filled with Sf₆ gas independent of two other poles (for 245 & 145 kV CBs) and the Sf₆ 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 SF_6 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 SF_6 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 datasheet.

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 aluminum 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 SUPPORTSTRUCTURES

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 datasheet.

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 NAMEPLATES

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 TERMINALCONNECTORS

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 withstands 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 units 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-COMMISSIONING 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 CIRCUITBREAKER

	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 exceeding 50ms	Not exceeding 50ms
	ii) Closing Time	ms	Not exceeding 120ms	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 OUTDOOR CURRENT 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 Purpose application.
 - (v) IS:3156(Part-I) Potential transformers: General requirement.
 - (vi) IS: 3156 (Part-II) Potential transformers: Measuring Potential transformers
 - (vii) IS: 3156 (Part-III) Potential transformers: Protective Potential transformers

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 610gm/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 3.0mm. 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 IS2147).
- 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 25mm/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 datasheet.

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 $U_m/\sqrt{3}$ and 10kV

5.7.1.3 At factory/works tests the Tan Delta shall not exceed 0.3% (at $U_m/\sqrt{3}$). 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.

5.7.2.2 Type test certificates so furnished shall not be older than 5 (five) years as on date of Bid opening.

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 this two terminal suitable for 40mmX10mm 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-COMMISSIONING 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 POTENTIAL TRANSFORMERS

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.

<i>Item</i>	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 $U_m/\sqrt{3}$, (Max)	0.3%	0.3%	0.3%
(H) Temperature rise	As per ISS		
(I) Feeder/ BYPASS/ Bus Coupler CT			
(i) No. of Cores	5	3	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	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	PS	PS
(d) Core-4	PS	PS	PS
(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	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	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	N.A	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	N.A	N.A
(e) Core-5	3	N.A	N.A
(ix) Maximum exciting current, at $V_k/4$ mA			
(a) Core-1	-	-	-
(b) Core-2	20	-	-
(c) Core-3 (at $V_k/4$)	20	20	20
(d) Core-4	20	N.A	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 $V_k/4$ mA			
(a) Core-1	-	-	-
(b) Core-2	3	-	-
(c) Core-3 (at $V_k/4$)	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)	$(220 \text{ kV}/\sqrt{3})$ / $(110 \text{ V}/\sqrt{3})$	$(132 \text{ kV}/\sqrt{3})$	$33 \text{ kV}/\sqrt{3}$

(b)	Winding II		$I/(110V/\sqrt{3})$	$I/110V/\sqrt{3}$
(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

POTENTIAL TRANSFORMER (Metering)

SN	Particulars	132kV PT (metering)
	II	IV
1	Type	Single phase, 50Hz, oil filled, self-cooled, Hermetically sealed, outdoor, Porcelain type.
2	Nominal system voltage.	132kV
3	Highest system voltage.	145kV.
4	Frequency.	50Hz+5%
5	System earthing.	Effectively, Solidly earthed
6	Number of phases.	3[single phase]
7	Number of secondary windings. Purpose of windings.	2[two] metering.
8	Rated primary Voltage.	132/1.732kV
9	Rated secondary Voltage.	Winding-I & II-110/1.732V (Metering)
10	Ratio	132kV/1.732: 110V/1.732 110V/1.732
11	Rated Burden	Winding I(M)-100VA, Winding-II(P)-

12	Accuracy class	0.2/0.2
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13	Rated voltage factor at rated frequency.	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.
15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency & rated burden.	As per IEC- 186.
16	One-minute power frequency dry/wet withstands test voltage for primary winding.	275kV[rms]
18	1.2/50 micro second impulse withstand test voltage for primary winding	650kV[peak]
19 (i) (ii)	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal	3kV[rmsj]

20	Class of insulation.	B
21	Material of the conductor of primary and secondary windings	Copper.
22	Fault level	40 kA [rms] for 3 second.
23	Minimum creepage distance.	4495mm
24	Quality of oil.	EHV Grade As per IS-335.
25	Radio interference voltage at 1.1 times Maximum rated voltage at 1.0 MHZ.	500 micro volts.
26	Partial discharge level.	Less than 10 piccoulombs.

27	Seismic acceleration Horizontal — Vertical —	0.5g. 0.6g.
28	Accuracy class of standard V.T. to be used during testing towards determination of ratio errors and phase angle errors for metering	0.05 or better.
29.	Capacitance (Pf)	-

Note:

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

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

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

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

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 Section1.

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 EARTHINGSWITCHES

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 OPERATINGMECHANISM

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 (minimum 3mm).

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

pushbuttons.

- 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 overtravel.

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

	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	31.5
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	460	275	70

	poles			
	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 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 arrester 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 arrester 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 arrester shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrester shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrester 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 Arrester.
- 7.3.6** The surge arrester shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrester shall change over to the conducting mode.
- 7.3.7** The surge arrester 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 failure.
- 7.3.9** The reference current of the arrester 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 ARRESTORHOUSING

- 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 takeoff.
- 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:

Residual voltage test

Reference voltage test Leakage current at M.C.O.V

P.D. test Sealing test

Thermal stability test

Aging and Energy capability test Watt loss test

Each metal oxide block shall be tested for guaranteed specific energy capability in addition to routine/acceptance test as per IEC/IS.

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

7.7.3 Galvanization Test

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

7.8.0 NAME PLATE

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

Rated Voltage

Continuous Operation Voltage Normal discharge current Pressure relief rated current Manufacturers Trade Mark Name of Sub-station

Year of Manufacturer Name of the manufacture

Purchase Order Number along with date

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 of arrester insulation, kV (rms)	460	275	70
7	1.2 / 50 μ 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 TECHNICAL SPECIFICATIONS FOR CONTROL & RELAY PANELS:

- a) This Section is intended to cover the design, manufacture, assembly, testing at manufacturer's works and erection, testing & commissioning of Indoor Relay and Control Panels.
- b) The Control and Relay Panels required are for control and protection of the Power Transformers and Feeders according to requirements. The supply shall include all accessories, special tools, supporting steels, spare parts, drawings, relevant software, instruction manuals etc. The panels shall be supplied complete with all accessories as specified and completely assembled and all internal wiring completed.
- c) The sub-stations shall have automation as per IEC 61850 protocol in Bay & Station level. The bidder has to supply the C&R panels to match the requirement of Sub-station Automation System (SAS) as specified in the subsequent chapter, **from the same manufacturer.**
- d) **The manufacturer/supplier of Control and Relay Panels shall necessarily be an OEM (Original Equipment Manufacturer) of Numerical Protective Relays, Bay Control Units and Sub Station Automation System (SAS), having registered servicing unit in India.**
- e) Design and fabrication of Control & Protection Panels for mounting the relay and relay assemblies along with all necessary accessories like switches, indicating lamps etc. and wiring up of the same to provide self contained and ready to use protection as per this specification.
- f) Complete testing at manufacturer's works of the relays and protection schemes **including SAS** after mounting and fully wiring up in the Control & Protection Panels.

8.2.0 STANDARDS:

All equipment and all component parts supplied under this specification shall conform in all respects to the latest issue of relevant IEC and 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 SERVICE CONDITIONS:

The plant and materials supplied shall be suitable for operation under the following climatic and other conditions as mentioned in chapter 2 of this Bid document:

8.4.0 TYPE TEST REPORTS.

- 8.4.1 Equipment, which have never been tested for critical performance, shall not be accepted. In such cases, a promise or agreement by a bidder to have the equipment tested after award of a contract is not acceptable.
- 8.4.2 All Bids must be accompanied by the full Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if:
 - i) Tests are conducted in KEMA/NABL accredited laboratory, *for GOOSE messaging etc as per relevant IEC 61850 Standards.*
 - ii) Inter-operability Tests are conducted in manufacturer's own laboratory. In this case (i) the laboratory must have ISO 9000 (or its equivalent) series certification; and (ii) tests have

been witnessed by technically qualified representatives of earlier Indian clients of Central/State Transmission Utilities.

- iii) The Validity of the Type Test Reports of CRP, Relays, BCUs and Energy Meters shall be as per CEA's "Guidelines for the Validity Period of Type Tests Conducted on Major Electrical Equipment in Power Transmission System", File No CEA-PS-14-80/1/2019-PSETD Division-Part (2).

8.5.0 TYPE OF PANEL

- 8.5.1 All simplex panels shall be swing type with front glass door with locking arrangement. The **Minimum number** of Panels shall be as per Table 1 below:

Table -1

	400kV	220kV	132kV	33kV
Feeder Panel	4 Nos if SWLR	2 Nos	2 Nos	1 No
Bus Coupler/Tie Breaker/Sectionalizer Panel	2 No	1 No	1 No	1 No
Reactor Panel	2 No			
Bus Bar Protection panel	4 Nos	2 Nos		
Transformer Panel	400/220/33kV AT	220/132kV AT	132/33kV PT	
	3Nos (Minimum)	2Nos (Minimum)	2 Nos (Minimum)	

8.5.2 Swing type Simplex Control and Relay Panels shall consist of vertical swing front panels with equipment mounted thereon and having front glass door. As there will be no rear door, manufacturer shall have to keep suitable swing angle, for maintenance & testing of equipment, circuitry inspection etc. Panel front shall have lockable glass door.

8.5.3 These panels shall be of the **Simplex type** with the following approximate dimensions:

- Height: 2250mm + 15mm anti-vibration pad + 50 mm (base)
- Depth: 800mm to 1000 mm
- Width: 800 mm to 1000 mm
- Operating Height: 1800 mm

14.5.4 For 33kV feeder, panel shall be of simplex type and it should accommodate one 33kV feeder in

a single cubicle and one BCU will control single 33kV feeder.

8.6.0 CONSTRUCTIONAL FEATURES:

- The panels shall be completely metal enclosed to ensure a dust, moisture and vermin proof atmosphere. The enclosure shall provide a degree of protection not less than IP 54 in accordance with IS-2147/IEC-60529.
- 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 3.15 mm for weight bearing members of the panels such as base frame, front sheet and door frames and not less than 2.0 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.
- All joints shall be made flush and all edges shall be bent at right angles and rounded. All structural members shall be bolted or welded together. Necessary arrangement shall be

provided for bolting together the adjacent panels as well as for fastening them to the floor. The opening required for mounting the equipment shall be punched or cut and filed smooth.

- d) 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.
- e) 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.

8.7.0 MOUNTING OF EQUIPMENTS:

- a) 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.
- b) Bay level intelligent electronic devices (IED) BPU for protection and control (BCU) and the Managed Ethernet Switch shall be housed in the C&R panels installed in the local control room.

8.8.0 INTERNAL WIRING:

- a) 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 supplier.
- b) Bay level intelligent electronic devices (IED) for protection, control (BCU) and the Managed Ethernet Switch shall be housed in the C&R panels installed in the local control room.
 - i) All Circuits except instrument transformers **and incoming AC/DC Supply** circuits: 1.5 sq. mm. per lead.
 - ii) Instrument transformers circuit: 2.5 sq. mm. per lead.
- c) 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.
- d) 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.
- e) 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 interconnection to adjacent panels at site and wires for this purpose shall be provided by the supplier looped and bunched properly inside the panel.
- f) A laminated copy of total schematics is to be fixed on the inside of door.

8.9.0 TERMINAL BLOCKS:

- a) 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 1100 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.

- b) 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.
- c) At least 20% spare terminals shall be provided on each panel and these terminals shall be uniformly distributed on all terminal blocks.
- d) 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 150 mm. A steel strip shall be connected between adjacent terminal block rows at 450-mm intervals for support of incoming cables.

8.10.0 PAINTING:

- a) All Sheet steelwork shall be phosphated in accordance with IS 6005.
- b) 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.
- c) 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.
- d) 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.
- e) Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- f) The inside of the panels shall be glossy white.
- g) A small quantity of finishing shall be supplied minor touching up required at site after installation.

8.11.0 NAME PLATES AND MARKINGS:

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

8.12.0 MISCELLANEOUS ACCESSORIES:

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

- c) 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 supervision, signalling, 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.
- d) Pistol Grip Trip Switch shall be provided.

8.13.0 EARTHING:

- a) 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 **25X6 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.
- b) 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.
- c) PT and CT secondary neutrals or common lead shall be earthed at one place only at the terminal blocks, where they enter the panels.

8.14.0 RECORDING METERS (ABT TRIVECTOR METERS):

8.14.1 General

- a) All meters shall be housed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. They shall be accurately adjusted and calibrated at works and shall have means of calibration, check and adjustment at site.
- b) All these instruments and meters shall be flush mounted type and back connected, suitable for front panel mounting.
- c) The ABT meters shall be SAMAST compatible as per specification given in subsequent chapter.
- d) The meters should be compatible to IEC62052-11 and IEC62053-22, IEC62053-24, IS14697, IS15959.
- e) The manufacturer shall provide Performance Certificate from CTU/STU of successful operation of minimum 3 years as on BID Opening.

8.15.0 RELAYS:

8.15.1 General

- a) All relays shall conform to the requirements of IS 3231/ IEC 60255/ IEC 61000 or other relevant standards. The relay firmware/software shall be of the latest version.
- b) 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.
- c) Two sets of relevant software (latest version) for relay configuration & setting, maintenance etc to be supplied to each station. The numeric relay and software shall be upgradable.
- d) The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay's coils and contacts, including spare contacts.

- e) Relays shall be suitable for flush or semi-flush mounting with connectors from rear.
- f) 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. All protective relays shall be with proper online testing facilities without isolation from TB where inputs viz CT/ PT and DC are wired. All main relays shall be provided with test plug to test the relay online & required test handle may be invariably indicated. Necessary test plug shall be in the supplier's scope of supply and shall be supplied loose. Unless otherwise specified all auxiliary relays and timers shall be supplied either in non-draw out cases or plug in type modular cases.
- g) All A.C. relays shall be suitable for operation at 50 Hz. A.C. Voltage operated relays shall be suitable for 110 volts VT secondary and current operated relays for 1Amp. CT 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. Voltage operated relays shall have adequate thermal capacity for continuous operation.
- h) 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 externally/ electrically reset positive action operation indicators provided with proper inscription. All protective relays which do not have built-in hand reset operation indicators shall have additional auxiliary relays with operating indicators for this purpose. 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.
- i) No control relays that shall trip the circuit breaker when the relays are de-energized shall be employed in the circuits.
- j) All relays shall withstand a test voltage of 2.5 kV, 50 Hz rms. voltage for one second. In case of static relays, the Clause 14.28.1.I shall be applicable.
- k) Auxiliary seal-in unit provided in the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:
 - (i) The operating time of the series seal-in unit shall be sufficiently shorter than that of the trip coil relay in series with which it operates to ensure definite operation of the flag indicator of the relay.
 - (ii) Seal - in unit shall obtain adequate current for operation when one or more relays operate simultaneously.
 - (iii) Impedance of the seal-in unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when D.C. supply is minimum.
 - (iv) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.
 - (v) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).
 - (vi) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be

independently settable for single- and three-pole tripping.

(vii) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

l) Whenever solid state auxiliary relays are used the following requirements shall be met with:

i) The printed circuit cards shall be of fibre glass type and the contact shall be gold plated. All connectors with the connector pegs shall be through wire wrapping. All solder Joints on the printed circuit boards shall be encapsulated or covered with varnish.

ii) The components shall be loaded by less than half of their rated values. The resistor shall be of carbon composition or metal oxide type and the capacitors shall be plastic film or tantalum type. Stringent measures including shielding of long internal wiring should be taken to make relays immune to voltage spikes. Relays must withstand 5kW, 1x150 microsecond, 0.5 Joule source energy impulse test or 1.5 MHz damp oscillations with initial value of 2.5 kV decaying to half the initial value in 6 microseconds with internal source impedance of 150 ohms.

iii) The supplier shall ensure that the terminals of the contacts of the relays are readily brought out for connectors as required in the final approved scheme.

iv) DC /DC converter shall be provided in the solid state protective relays wherever necessary in order to provide a stable auxiliary supply for relay operation. Provision of DC cell in the protective relays as relievable stand-by power supplies will however not be acceptable.

m) Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

n) All Spare pair of contacts of all IEDs and Alarm Relays shall be wired to Terminal Blocks exclusively for Employer's use.

o) All relays and their drawings shall have phase indications as R-Red, Y-Yellow, B-Blue.

p) The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

8.15.2 General Specification of Numerical Relays

a) Numerical Relays shall be provided for the following applications:

- i) Distance Protection (Main I & Main II) of different make and model for 400KV and 220 kV lines.
- ii) Distance protection for 132 kV lines.
- iii) Back up directional over current and earth fault relays for 132 kV Lines.
- iv) Back up non directional over current (3 O/C) and earth fault relays for 33kV lines
- v) Bus Bar Protection.
- vi) Integrated Numerical Transformer Differential Protection as Main –I & Main-II of different make **and model** with non-directional overcurrent and earth fault function with high set units for power and autotransformers/ reactors.
- vii) Reactor Protection.

viii) *Line Differential Protection*

(viii) 3 winding transformer protection relay for Main-1 & Main-2 shall be provided for all the transformers under the scope of this bid

b) All Numerical Relays should have following minimum features.

- i) Relays shall be communicable on IEC61850 protocol without any protocol converter. Certificate from KEMA confirming interoperability, Goose messaging & publishing as per IEC61850 standard shall be submitted along with the tender. The relay shall have suitable communication facility for future connectivity to SCADA.
- ii) Relays shall have one no. front RJ45 or USB port (for RS 232 port Converter to USB shall be supplied for each substation along with spare) for Local Relay Parameterization and Two nos. rear FO port for connectivity to SAS over IEC61850 protocol.
- iii) The relay shall have self-communication port monitoring feature and failure shall generate alarm.
- iv) The relay shall have sufficient battery back up to keep the internal clock running for at least 2 years in absence of auxiliary supply. The capacitor discharging power is not sufficient and won't be accepted. Proper battery back must be provided.
- v) Should have minimum 12 configurable LEDs for 132kV and above voltage class.
- vi) Should have minimum **24 Binary Inputs and 32 Binary Outputs**. Moreover, the relays shall have minimum 30% BI & BO as spare after fulfilment of scheme requirement.
- vi) All BI/BOs shall be site configurable
- vii) Shall have front minimum 3 lines LCD display with Alpha numeric keypad.
- viii) Numerical relays are to be provided with built in Event / Disturbance / Fault Recorder features.
- ix) 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.
- x) The relays shall be site configurable (Including logic development)
- xi) Configured features & set values shall be in non-volatile memory
- xii) Must have real time clock for time stamping of events/ disturbances with time synchronization inputs (GPRS etc.). Time synchronisation through SNTP compatible.
- xiii) The major component cards shall be hot swappable and front or rear loading.
- xiv) The relays should have self-diagnostic features identifying area of fault or failure of a particular component or card.
- xv) 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.
- xvi) Relay shall have inbuilt PRP ports.

- xvii) Relays shall have redundant communication channels for Protection Communication.
- c) Hardware based measurement shall not be acceptable.
- d) The relay should have high immunity to electrical and electromagnetic interference.
- e) The same relay shall be provided with both 1A CT inputs and shall be site selectable.
- f) It shall be possible to energise the relay from either AC or DC auxiliary supply. Auxiliary dc supply shall be suitable for both 110 and 220 Volt and shall be site selectable.
- g) 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.
- h) 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.
- i) 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.
- j) Must have additional feature of local breaker back up protection
 - i) The relay shall have built in Circuit Breaker Supervision Functions.
 - ii) The relay shall be able to detect any discrepancy found between NO & NC contacts of breaker.
 - iii) The relay shall monitor number of breaker trip operations.
 - iv) The relay shall also monitor the breaker operating time.
- k) The relays shall have the following tools for fault diagnostics:
 - i) Fault record (shall be function of IED): – The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters.
 - ii) Event record (shall be function of IED): – The relay shall have the facility to store time stamped event records with 1ms resolution.
 - iii) Disturbance records (shall be function of IED): – The relay shall have capacity to store disturbance records of at least 10 sec. duration and sampling rate per cycle shall be more than 15.
- l) It shall be possible to preserve stored information in the event of an auxiliary supply failure with the help of a battery backup.
- m) The relay settings shall be provided with password protection.
- n) It shall be possible to change the relay setting from the front panel using the key pads/ Work station of SAS and Laptop.
- o) 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.

- p) The Numerical Relays shall be provided with 2 sets of common support software (latest version) compatible with latest version of Windows OS which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, and measurements to Station HMI/ DR Work Station. The relay settings shall also be changed from local or remote using the same software.
- q) In case of line protection and transformer/reactor protection, the features like fault recorder, disturbance recorder and event logging function as available (including if available as optional feature) in these relays shall be supplied and activated **at no extra cost to the owner**.
- r) The manufacturer shall have to provide up-graded support software if any within 10 years span.

8.16.0 Transmission Line Protection :

8.16.1 Line Differential Protection Relay (If Applicable)

Main I and Main II Line Differential Protection shall be of **different make and model**.

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 I_n
 2. Slope (Single/dual) - 10 to 100%
 3. End section (Single/dual) - 20 to 1000% of I_n
 4. Highset operating current - 100 to 5000% of I_n
 5. 2nd Harmonic blocking - 5 to 100 %
 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

8.16.2 Distance Protection Relay

- i) The distance protection relay shall be fully numerical using microprocessors and be based on a non-switched scheme.
- ii) 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.
- iii) Have non-switched measurement, which implies processing of six possible fault loops (six – loop measurement).
- iv) The protection algorithm shall utilize fault voltages and currents, as well as the superimposed voltages and currents to arrive at a secure trip decision in the shortest possible time with reliability, selectivity and full sensitivity to all types of faults online.
- v) 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.
- vi) 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.
- ix) 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 plus 50 % of the next section, zone-3 shall normally cover the two adjacent sections completely. The zones must have independent time settings.
- x) Shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)

- xi) All the zones shall have setting such that they can detect the fault online from minimum 0.3 km to 500 km.
- xii) The maximum fault current could be as high as 63kA but the minimum fault current could be as low as 20% of rated current. The starting and measuring relays characteristics should be satisfactory under these extreme varying conditions.
- xiii) The relay shall use the memory voltage for proper directional discrimination at close in 3 phase fault which shall be based on positive sequence voltages. The directional discrimination and phase selection based on negative sequence measurement techniques is not acceptable.
- xiv) 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, overreach, & blocking and non-carrier aided schemes of zone 1 extension and Loss of load accelerated tripping schemes shall be available as standard. Weak in feed logic and current reversal guard also shall be provided.
- xv) 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.
- xvi) Shall have suitable number of potential free contacts for Carrier Aided Tripping, Auto Reclosing, CB Failure, Disturbance/Fault recorder and Data Acquisition System.
- xvii) 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. Isochronic curves shall be provided in support of operating times.
- xviii) Shall have an independent Directional Earth Fault (DEF) protection element to detect highly resistive faults as a built in feature. This element shall have an inverse time/definite time characteristic.
- xix) 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.
- xx) 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.
- xxi) 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.
- xxii) Have power swing blocking and Out of Step protection 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. It shall be on the principle of measurement of the rate of impedance vector change and monitoring of the vector path. It should have the Earth fault detection feature, which shall override power swing blocking and allow the relay to operate for trip as per zone detection. The relay shall be blocked for the set time for the first PS sensed and remain unblocked for the set time for the successive PS.
- xxiii) Be suitable for single pole or three pole tripping. However, relays offered for 132 kV lines provided with mechanically ganged circuit breakers, single pole tripping need not to be provided.
- xxiv) Be suitable for both bus PT or Line PT/ CVT supply.
- xxv) Shall have in built Trip circuit supervision facility to monitor both pre- and post close supervision facilities. An alarm shall be generated.
- xxvi) Shall have in built broken conductor detection by way of level detector or negative sequence measurement.
- xxvii) Shall have df/dt functions.

- xxviii) Shall have multistage under frequency setting options.
- xxix) The sensitivity of the logic shall not be affected during operation under low load.
- xxx) Shall have a fault locator with an accuracy of $\pm 3\%$. The display should be in kilometres and preferably in percentage impedance too. The fault locator should have built in mutual compensation for parallel circuit.
- xxxi) Have mutual zero sequence compensation factor setting. The relay shall have facility to select different group settings to cater for mutual coupling on account of multi circuit line conditions. The minimum no. of group should be four.
- xxxii) Have at least 24 no of programmable BI and 32 no of programmable BO contact to cater for DR/SER carrier aided tripping auto re-closing etc.
- xxxiii) The distance relays 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 deadline charging/dead bus charging / check synchronising shall be included. However, the relay shall support independent A/R scheme.
- xxxiiii) Shall have additional features to provide under/ over voltage protection.
- xxxv) Shall have additional features to provide under frequency protection
- xxxvi) Shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3 phase fault.
- xxxvii) The protective relays shall be suitable for use with capacitor voltage transformers having non electronic damping and transient response as per IEC.
- xxxviii) Shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall be also capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.
- xxxix) Must have a current reversal guard feature.
- xl) Shall have Stub Protection function with current setting minimum range of 1 to 3 pu with definite time delay setting, minimum range of 0 to 100 msec
- xli) Have feature of load encroachment blinder to safeguard the protection trip during heavy line loading condition.

8.16.3 Integrated Numerical Transformer Protection Relay

a) GENERAL REQUIREMENTS:

- i) Shall be stable during magnetising inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents.
- ii) Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
- iii) Shall have zero sequence current filtering, which may be deactivated separately for each winding, for special applications.
- iv) Shall have software to take care of the angle & ratio correction of CT inputs.
- v) Shall have all output relays suitable for both signals and trip duties

b) FUNCTIONAL DESCRIPTIONS:

The integrated Numerical Transformer Protection Scheme shall have following functional qualities:

1) Differential protection:

- i) The relay shall be biased differential protection with triple slope tripping characteristics with faulty phase identification / indication. The range for the differential pick-up shall be from 0.1 to 2.5 p.u. Its operating time shall not exceed 30 ms at 5 times rated current.
- ii) The relay shall have two adjustable bias slopes from 20 % to 150 % and slope from 40% to 150 %, to provide maximum sensitivity for internal faults with high stability for through faults
- iii) The relay shall have an unrestrained high set element to back up the biased differential function and the setting range for it shall have a minimum setting of 5pu and a maximum setting of 30pu.
- iv) The relay shall have the second harmonic restraint feature for stability under transformer inrush condition. The setting shall be 15-25%.
- v) Further, the fifth harmonic blocking for stability under transient over fluxing condition shall be provided.
- vi) Have suitable non-linear resistors along with stabilizing resistor for CT Circuit to limit peak voltage during in-zone faults in case of high impedance type.
- vii) Have a fault recording feature to record graphic form of instantaneous values of following analogue channels during faults and disturbances for the pre fault and post fault period: **Current in all three windings in nine analogue channels plus three analogue channels for Backup protection in case of 400kV class/ 220kV Class (In case of loaded tertiary) or 9 analogue channels for lower voltage transformers and voltage in three channel.**
- viii) The Disturbance recorder function built in the Differential Protection IED shall have the facility to record the following external digital channel signals associated with transformer which shall be wired to differential relay apart from the digital signals pertaining to differential relay:
 - a) REF Protection Operated
 - b) HV Breaker Status (Main & Tie/Transfer both separately)
 - c) IV/LV Breaker status (Main & Tie/Transfer both separately)
 - d) Bucholz/OLTC/OTI/WTI alarm
 - e) Bucholz/ PRD/ SPR Trip
 - f) Group-A/ Group-B lockout relay trip

Necessary hardware and software, for automatic up loading of the data captured by disturbance recorder to the personal computer (DR Work Station) available in the sub station, shall be included in the scope.
- ix) The Relay shall have Reverse Power Protection feature.
- x) The Differential Relay shall be designed for the protection & control of 3 winding Transformer

2) Restricted Earth fault Protection:

The scheme shall have in-built restricted earth Fault (REF) for both the windings. The REF function shall be configurable to Auto Transformer also. This function should be provided to maximise the sensitivity of the protection of earth faults. **Both the Differential relay shall have inherent high impedance REF element.** The REF function should be able to share Current Transformers with the biased differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents. For star/star transformer, both the windings shall be protected through REF, as such relay shall have sufficient analogue channels to accommodate the same.

3) Over fluxing Protection:

- i) The over fluxing protection shall be built in the relay. By pairs of V/f and t , it shall be possible to plot the over fluxing characteristics so that accurate adaptation of the power transformer data is ensured.
- ii) In addition, the relay should have a definite time element for alarm.
- iii) The relay should monitor all the three phase voltages for calculation of V/f and should take the highest voltage for V/f calculation.

4) Thermal Overload Protection:

- i) Shall have two stages of thermal overload protection for alarm and trip condition with continuously adjustable setting range of 100-400% of rated current and time constant setting range of 1.0 to 10.00sec continuously.
- ii) Shall be single pole type.
- iii) Shall have a drop off/pick up ratio greater than 95%.
- iv) Shall have separately adjustable time delay relays for alarm having a setting range of 1 to 10 seconds continuously.

5) Over Current and Earth fault protection:

- i) The relay shall have three stages of definite time **Directional** over current protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current.
- ii) In addition, the relay shall have three stages of Inverse time **Directional** over current protection operating based on one measuring system each for the three phase currents, the negative sequence current and the residual current.
- iii) Shall have additional features to provide under/ over voltage protection.
- iv) Shall have additional features to provide under frequency protection.
- v) The Earth fault relay shall have directional IDMT characteristic with a definitive minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current. (with selectable IEC Curves).
- vi) The Earth fault relay shall have low transient, overreach high set instantaneous unit of continuously variable setting range 200-800 % of rated current.

6) Transformer Neutral Current relay (for 400 KV class transformer only) shall

- i) Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current. (with selectable IEC Curves)

8.16.4 Over Current and Earth Fault Relays

These relays shall be of numeric, single/multi pole, directional /non-directional type with high set element as specified. These relays shall have the following features/characteristics:

- (i) IDMT characteristic with definite minimum time of 3 second at 10 times setting.
- (ii) Other operating curves such as inverse, very inverse shall be selectable
- (iii) Adjustable setting range of 50-200 % and 20-80% of rated current for over current and earth fault relays respectively.
- (iv) The directional relays shall have a Maximum torque angle of 45° current leading for directional over current unit & 30 lag for directional earth fault. Other MTAs should be settable
- (v) Voltage polarizing coil: 63.5 or 110volt

- (vi) Must have faulty phase, type of fault identification
- (vii) The directional relays shall have over voltage/ under voltage & under frequency built in protection
- (viii) The relay shall have blocking scheme on Reverse Power Flow.
- (ix) Include LED indicators.

8.16.5 Reactor Protection

8.16.5.1 REACTOR DIFFERENTIAL PROTECTION RELAY Shall

- (i). Be triple pole type.
- (ii). Have operation time less than 25 milli-seconds at 5 times setting
- (iii). Be tuned to system frequency.
- (iv). Have an operating current sensitivity of at least 10% of nominal current
- (v). Have current setting range of 10 to 40% of 1 Amp. or a suitable voltage setting range
- (vi). Be high impedance / biased differential type.
- (vii). Have suitable non-linear resistors along with stabilizing resistor for CT Circuit to limit peak voltage during in-zone faults in case of high impedance type.
- (viii). Be stable for all external faults.

8.16.5.2 REACTOR RESTRICTED EARTH FAULT PROTECTION RELAY shall

- (i). Be single pole type.
- (ii). Be of current/voltage operated high impedance type.
- (iii). Have a current setting of 05-40% of 1 Amp. / have a suitable voltage setting range
- (iv). Be tuned to system frequency
- (v). Have a suitable non-linear resistor to limit the peak voltage to 1000 Volts.

8.16.5.3 REACTOR BACK UP IMPEDANCE PROTECTION RELAY shall

- (i). Be triple pole type, with faulty phase identification/ indication.
- (ii). Be single step polarized 'mho' distance/ impedance relay suitable for measuring phase to ground and phase to phase faults
- (iii). Have adequate ohmic setting range to cover at least 60% of the impedance of the reactor and shall be continuously variable
- (iv). Have an adjustable characteristic angle of 30-80 degree
- (v). Have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds
- (vi). Include VT failure relay which shall block the tripping during VT fuse failure condition.
- (vii). Have Back Up over Current and Earth fault protection as built in function.

8.16.6 Circuit Breaker Protection

a) LOCAL BREAKER BACK-UP PROTECTION SCHEME shall

- (i). Be triple pole type.
- (ii). Have an operating time of less than 15 milli seconds
- (iii). Have a resetting time of less than 15 milli seconds
- (iv). Have three over current elements
- (v). Be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer /reactor equipment protections
- (vi). Have a setting range of 10-80% of rated current
- (vii). Have a continuous thermal withstand two times rated current irrespective of the setting

- (viii). Have a timer with continuously adjustable setting range of 0.1-1 seconds
- (ix). Have necessary auxiliary relays to make a comprehensive Scheme
- (x). Shall have re-trip feature for tripping its own CB after initiation with a set time delay.
- (xi). Be acceptable as Built-in protection function of distributed bus bar protection scheme only; however in that case separate LBB relay shall be provided for tie bays.

b) **NUMERICAL AUTO RECLOSING FUNCTION** (where specified) shall be an in built feature of Main-I and Main-II protection relay. The Auto Reclose shall

- (i). Have single phase and three phase reclosing facilities.
- (ii). Have a continuously variable single-phase dead time range of 0.1-2 Seconds
- (iii). Have a continuously variable three phase dead time range of 0.1-2 Seconds
- (iv). Have a continuously variable reclaim time range of 5-300 seconds
- (v). Incorporate a four-position selector switch/ from which single phase/three phase/single and three phase auto-reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through HMI of the relay or BCU & SAS.
- (vi). Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.
- (vii). Be of single shot type
- (viii). Have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers
- (ix). Include check synchronizing relay which shall
 - Have a time setting continuously variable between 0.5-5 seconds with a facility of additional 10 seconds
 - Have a response time within 200 milli seconds with the timer disconnected.
 - Have a phase angle setting not exceeding 35 degree
 - Have a voltage difference setting not exceeding 10%
 - Include deadline charging relay, which shall
 - Have two sets of relays and each set shall be able to monitor the three-phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
 - Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

Auto Reclose function shall be an in-built feature of the BCU and the signal exchange for auto-reclose function from BCU to main relays and vice versa shall be achieved through hard wiring and GOOSE parallelly.

8.17.0 Bus Bar Protection Relay

- a) These relays shall also be of numeric type.
- b) Redundant (1+1) numerical low impedance biased differential Bus Bar protection scheme for each bus system (Bus1 +Bus2) for 400kV shall be provided. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same.
- c) Single bus bar protection scheme shall be provided for each main bus (**Main I/Main II**) and transfer bus (as applicable) for 220KV and **132kV** voltage level.
- d) Each Bus Bar protection scheme shall
 - i) Have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value.
 - ii) Operate selectively for each bus bar

- iii) Give hundred percent security up to 63 KA for fault level for 400 KV , 50kA for 220 KV and 40 KA for 132 KV
 - iv) Incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm
 - v) Not give false operation during normal load flow in bus bars
 - vi) Incorporate clear zone indication
- e) It shall have End fault Protection & LBB function
- f). Be of phase segregated and triple pole type. The bus bar scheme may be Centralized or De-Centralized type and it must accommodate all future bays as per Project along with tripping relays.
- g) Provide independent zones of protection (including transfer bus if any). If the bus section is provided, then each side of bus section shall have separate set of bus bar protection schemes
- h) Include individual high speed electrically reset tripping relays for each feeder. However, in case of distributed Bus bar protection, individual trip relay shall not be required if bay unit is having trip duty contacts for breaker tripping.
- i) Be transient free in operation
- j) Include continuous D.C. supplies supervision
- a) Not cause tripping for the differential current below the load current of heaviest loaded feeder. Contractor shall submit application check for the same.
- b) Shall include necessary C.T. switching relays wherever C.T. switching is involved and have 'CT' selection incomplete alarm
- c) Include protection 'IN/OUT' switch for each zone
- d) Shall include trip relays, CT switching relays (if applicable) , auxiliary CTs (if applicable) as well as additional power supply modules, input modules etc. as may be required to provide a Bus bar protection scheme for the complete bus arrangement i.e. for all the bays or breakers including future bays as per the Single line diagram for new substations. However, for extension of bus bar protection scheme in existing substations, scope shall be limited to the bay or breakers covered under this specification. Suitable panels (if required) to mount these are also included in the scope of the work.
- e) In case of distributed Bus bar Protection, the bay units for future bays may be installed in a separate panel and the same shall be located in switchyard panel room where bus bar protection panel shall be installed.

8.18.0 Tee Differential Protection Relays (If Applicable)

- 1) **TEE-1 DIFFERENTIAL (BIAS) PROTECTION RELAY** shall
 - (a) be triple pole type
 - (b) have an operating time less than 30 milliseconds at 5 times the rated current
 - (c) have three instantaneous high set over current units
 - (d) have an adjustable bias setting range of 20-50%
 - (e) have an operating current setting of 15% of 1 Amp or less
- 2) **TEE-2 DIFFERENTIAL (HIGH IMPEDANCE) PROTECTION RELAY** shall
 - (a) be triple pole type
 - (b) have operating time less than 25 milliseconds at 5 times setting
 - (c) be tuned to system frequency
 - (d) have current setting range of 20 to 80% of 1 Amp
 - (e) be voltage operated, high impedance type

- (f) be stable for all external faults
- (g) be provided with suitable nonlinear resistors across the relay to limit the peak voltage to 1000 volts

8.19.0 Trip Circuit Supervision Relay

- Trip circuit supervision relay shall be provided for each pole of the breaker for both trip coils with separate DC source.
- The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
- The relay shall have adequate contacts for providing connection to alarm and event logger.
- The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

8.20.0 Master Trip Relay

- High Speed Tripping Relay shall be instantaneous (operating time not to exceed 10 milli-seconds)
- The relays shall reset within 20 milli seconds
- The relay shall be re-settable/configurable from local SCADA.
- The relays shall be D.C. operated
- The relays shall have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
- The relays shall be provided with operation indicators for each element/coil.

8.21.0 Other Trip Relays

- For transformer protection other trip relays for Buchholz, winding & oil temperature high, PRD etc. shall be provided as per requirement.
- These High-Speed Tripping Relays shall be instantaneous (operating time not to exceed 10 milli-seconds)
- The relays shall have adequate contacts to meet the requirement of scheme

8.22.0 DC Supply Supervision Relay

- The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
- It shall have adequate potential free contacts to meet the scheme requirement.
- The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and the relays shall be provided with operation indicator/flag.

8.23.0 TIME SYNCHRONISATION EQUIPMENT:

- The equipment must be Type tested for Shock, Vibration, Dry heat, Radiated Emission, Electromagnetic field immunity, Electrostatic discharge immunity test in a Standard Laboratory. Type test report shall be submitted along with the bid. Type tests shall be more than five years as on opening of this bid.
- The equipment shall be compliant to IEC 61850 Protocol. It shall also support the network protocols like NTPv4, SNTP, SNMPv1,2,3, SNMP Trap, SSH2, Ipv6, DHCP, HTTP (S), eMail, FTP, TELNET and Syslog
- 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.

- Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.
- 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.
- Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.
- The synchronisation equipment shall have 20 nano second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propagation & processing delays etc.) including communication time for satellite link to achieve real time signal.
- Equipment shall meet the requirement of IEC 60255 for storage & operation.
- The system shall be able to track the satellites to ensure no interruption of synchronisation signal.
- The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- 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:
 - 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
 - 5) RJ 45
 - 6) SNTP
 - 7) Optical
 - 8) IEEE 1588 PTP (Applicable only for process bus automation station)
- The equipment shall have a periodic time correction facility of one-second periodicity.
- 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%.
- 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/SAS Panels having display size of approx. 100 mm height.
- 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.
- Time Synchronisation software shall be window base and it should be provided free of cost after commissioning.

8.24.0 BAY CONTROL UNIT (BCU)

- The BCU must be type tested at KEMA/Internationally or nationally accredited other testing laboratories for IEC 61850 and other tests as per relevant IEC standards. The bidder is to submit type test reports along with the bid. The validity of type test report shall be as per Clause 14.4.2(iii).
- The bay unit shall use industrial grade components. The BCU shall be modular type. 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 even if there is any power off conditions during the day. **The BCU shall have Auto Reclose, LBB, U/O voltage and Synchronization function. The BCU shall have redundant power supply card i.e. in case of failure of one source/Card fail, the redundant shall pick up instantly. Power supply card failure shall generate necessary alarm to local SCADA.**

- The BCU must have metering functions like phase current, phase voltages, active & apparent power, power factor, frequency etc. The metering functions shall be accurate for a minimum of 1% of rated current.
- BCU HMI shall display complete mimic of the respective bay, and operator shall be able to select the equipment in the mimic diagram for which operation of equipment is required. The control operation shall be password protected. For 33kV, the HMI should display one bay and control thereof.
- The mimic diagram shall indicate the live & dead portion of the Bay.
- The BCU shall be capable to generate password for maintenance shutdown.
- One Bay level unit shall be provided for supervision and control of each 400KV, 220KV, 132kV and 33kV bay (a bay comprises of one circuit breaker and associated disconnectors, earth switches and instrument transformer). If the 33kV bus section comprises isolator only, then the isolator shall be controlled from the transformer LV side bay and same is the case for Bus PT Isolator which shall be controlled by Transformer LV side BCU. 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.
- The BCU shall have sufficient number of BI/BO as per the scheme requirement with additional 30% spare BI/BO.
- The Bay level units shall be installed in the control and relay panels located in the control room.
- 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.
- **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 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

- **Operator Interface**

The HMI of BCU shall display the following informations

- i) the bay name
- ii) the date and time

- iii) the Local / Remote/Maintenance bay mode
- iv) the auto-recloser function status (on / off),
- v) the synchrocheck function status (on / off),
- vi) the interlock function status (on / off),
- vii) a list of measurements (in real value)
- viii) the bay graphical representation
- ix) the bay events classified in a chronological order
- x) the bay alarms
- xi) the list of disturbance records available
- xii) Bay interlock diagram

In addition, it shall be possible to plug a PC laptop on the Bay and get the full substation operator interface.

8.25.0 SWITCHED ETHERNET COMMUNICATION INFRASTRUCTURE:

The bidder shall provide the redundant managed switched optical Ethernet communication infrastructure for SAS against PRP architecture. The necessary switches are provided for communication infrastructure as follows.

- 8.25.1 One switch shall be provided to connect all IEDs for 1 Bay in LAN –I and the second optical port of Bay IEDs shall be connected to other Ethernet Switch in LAN-2. The maximum number of bays may be connected to these Ethernet Switch shall be two bays for 400KV, 220kV and 132kV. However, for 33kV, 3 numbers bay may be connected to one Ethernet Switch in this PRP architecture. The exact no of Ethernet switches required for complete implementation of the scheme shall decided during detailed engineering.
- 8.25.2 The managed Ethernet switch shall have minimum 20% port redundancy (Both Fibre & Copper ports).
- 8.25.3 Ethernet Switches shall have redundant power card.
- 8.25.4 Port monitoring softwares for Ethernet Switches are to be provided.
- 8.25.5 The make of the Ethernet switches shall be Ruggedcom/Hirschman/ABB.

8.26.0 FAULT RECORDER:

- 8.26.1 The fault recorder shall be provided for transmission line and the fault recorder as in-built feature of line distance relay is also acceptable provided the requirements of following clauses are met.
- 8.26.2 Fault recorder shall be capable to record the graphic form of instantaneous values of voltage and current in all three phases, open delta voltage & neutral current, open or closed position of relay contacts and breakers during the system disturbances.
- 8.26.3 The Fault recorder shall consist of individual acquisition units, one for each feeder and an Evaluation unit (as described in section sub-station automation through bus conforming to IEC 61850) which is common for the entire Substation. Necessary hardware and software shall also be supplied for online transfer of data from all acquisition units to Evaluation unit.
- 8.26.4 Fault recorder shall have at least 8 analogue and 16 digital channels for each feeder.
- 8.26.5 Acquisition units shall acquire the Disturbance data for the pre fault and post fault period and transfer them to Evaluation unit automatically to store in the hard disk. The acquisition units shall be located in the protection panels of the respective feeders.
- 8.26.6 The acquisition unit shall be suitable for inputs from current transformers with 1A rated secondary and capacitive voltage transformers with 63.5V (phase to neutral voltage) rated secondary. Any device required for processing of input signals in order to make the signals compatible to the Fault recorder equipment shall form an integral part of it. However, such processing of input signals shall in no way distort its waveform.

- 8.26.7 The equipment shall be carefully screened, shielded, earthed and protected as may be required for its safe functioning. Also, the Fault recorder shall have stable software, reliable hardware, simplicity of maintenance and immunity from the effects of the hostile environment of EHV switchyard which are prone to various interference signals typically from large switching transients.
- 8.26.8 The evaluation unit hardware shall be as described in clause no. 4.0 of section sub-station automation.
- 8.26.9 Necessary software for transferring the data automatically from local evaluation unit to a remote station and receiving the same at the remote station through owner's PLCC/VSAT/LEASED LINE shall be provided.
- 8.26.10 Evaluation software shall be provided for the analysis and evaluation of the recorded data made available in the PC under WINDOWS environment. The Software features shall include repositioning of analog and digital signals, selection and amplification of time and amplitude scales of each analogue and digital channel, calculation of MAX/MIN frequency, phase difference values, recording of MAX/MIN values etc. of analogue channel, group of signal to be drawn on the same axis etc, listing and numbering of all analogue and digital channels and current, voltage, frequency and phase difference values at the time of fault/tripping. Also, the software should be capable of carrying out Fourier /Harmonic analysis of the current and voltage wave forms. The Disturbance records shall also be available in COMTRADE format (IEEE standard- Common Format for Transient data Exchange for Power System)
- 8.26.11 The Evaluation unit shall be connected to the printer to obtain the graphic form of disturbances whenever desired by the operator.
- 8.26.12 Fault recorder acquisition units shall be suitable to operate from 220V DC as available at sub-station Evaluation unit along with the printer shall normally be connected to 230V, single phase AC supply. In case of failure of AC supply, Evaluation unit and printer shall be switched automatically to the station DC through Inverter of adequate capacity which shall form a part of Distance recorder system. The inverter of adequate capacity shall be provided to cater the requirement specified in section sub-station automation clause no. 8.0 and DR evaluation unit.
- 8.26.13 The acquisition unit shall have the following features:
- i) Facility shall exist to alarm operator in case of any internal faults in the acquisition units such as power supply fail, processor / memory fail etc. and same shall be wired to annunciation system.
 - ii) The frequency response shall be 5 Hz on lower side and 250 Hz or better on upper side.
 - iii) Scan rate shall be 1000 Hz/channel or better.
 - iv) Pre-fault time shall not be less than 100 milliseconds and the post fault time shall not be less than 2 seconds (adjustable). If another system fault occurs during one post-fault run time, the recorder shall also be able to record the same. However, the total memory of acquisition unit shall not be less than 5.0 seconds.
 - v) The open delta voltage and neutral current shall be derived either through software or externally by providing necessary auxiliary transformers.
 - vi) The acquisition unit shall be typically used to record the following digital channels:
 1. Main CB R phase open
 2. Main CB Y phase open
 3. Main CB B phase open
 4. Main-1 carrier received
 5. Main-1 protection operated
 6. Main/Tie /TBC Auto reclosed operated
 7. Over Voltage -Stage-1 /2 operated
 8. Reactor / Stub/TEE-1/2/UF protection operated
 9. Direct Trip received
 10. Main-2 carrier received

11. Main- 2/ Back Up protection operated
12. Bus bar protections operated
13. LBB operated of main /tie/TBC circuit breaker
14. Tie/TBC CB R phase open
15. Tie/TBC CB Y phase open
16. Tie/TBC CB B phase open

vii) In case the Fault recorder is in-built part of line distance protection, above digital channels may be interfaced either externally or internally.

viii) Any digital signal can be programmed to act as trigger for the acquisition unit. Analogue channels should have programmable threshold levels for triggers and selection for over or under levels should be possible.

8.26.14 The printer shall be compatible with the desktop PC and shall use Plain paper. The printout shall contain the Feeder identity, Date and time (in hour, minute and second up to 100th of a second), identity of trigger source and Graphic form of analogue and digital signals of all the channels. Two packets of paper (500 sheets in each packet) suitable for printer shall be supplied.

8.26.15 Each Fault recorder shall have its own time generator and the clock of the time generator shall be such that the drift is limited to +0.5 seconds/day, if allowed to run without synchronization. Further, Fault recorder shall have facility to synchronize its time generator from Time Synchronization Equipment having output of following types.

- i) Voltage signal: (0-5V continuously settable, with 50m Sec. minimum pulse duration).
- ii) Potential free contact (Minimum pulse duration of 50 m Sec.)
- iii) IRIG-B/SNTP
- iv) **RS232C/RS485/RJ 45/Optical port.**

The recorder shall give annunciation in case of absence of synchronizing within a specified time.

8.27.0 DISTANCE TO FAULT LOCATOR:

8.27.1 The Distance to Fault Locator shall be provided for transmission line and the fault locator as in-built feature of line distance relay is also acceptable provided the requirements of following clauses are met.

8.27.2 Distance to Fault Locator shall be electronic or microprocessor based and 'Online' type with built-in display unit.

8.27.3 The display shall be directly in percent of line length or kilometers without requiring any further calculations.

8.27.4 It shall have an accuracy of 3% or better for the typical conditions defined for operating timings measurement of distance relays. The accuracy should not be impaired under the following conditions:

- i) presence of remote end in-feed
- ii) predominant D.C. component in fault current
- iii) high fault arc resistance
- iv) severe CVT transients

8.27.5 It shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.

8.28.0 PROTECTION SCHEME FOR PANELS:

- **400KV Line Panel**

The following protections scheme shall be provided for Panels for 400 KV Transmission lines:

Main Protection Scheme I & II:

Distance protection scheme using Numerical Relay as specified in detail in Clause 14.15 and 14.16.2 shall be implemented. The summary of the scheme detailed in the above clauses

have the following feature:

- (i) Permissive under reach/over reach/ blocking communication mode.
- (ii) Suitable for single cum three phase tripping.
- (iii) Power swing blocking and out of step protection.
- (iv) Single shot single-cum-three phase auto re-closing with check synchronising and deadline charging features.
- (v) Fuse failure protection.
- (vi) Weak end in feed feature.
- (vii) Over/Under Voltage Protection
- (viii) Directional Over current and Earth Fault protection
- (ix) Current reversal guard feature
- (x) Stub protection function
- (xi) Load encroachment blinder feature.
- (xii) Switch on to fault feature.
- (xiii) In built Broken Conductor detection feature.
- (xiv) Shall have df/dt functions
- (xv) Under frequency protection
- (xvi) Carrier Aided Tripping
- (xvii) Main 1 and Main 2 relay shall of different make **and model**.

- **220 KV Line Panel**

The following protections scheme shall be provided for Panels for 220 KV Transmission lines:

- a) **Main Protection Scheme I & II:**

Distance protection scheme using Numerical Relay as specified in detail in Clause 14.15 and 14.16.2 shall be implemented. The summary of the scheme detailed in the above clauses have the following feature:

- (i) Permissive under reach/over reach/ blocking communication mode.
- (ii) Suitable for single cum three phase tripping.
- (iii) Power swing blocking and out of step protection.
- (iv) Single shot single-cum-three phase auto re-closing with check synchronising and deadline charging features.
- (v) Fuse failure protection.
- (vi) Weak end in feed feature.
- (vii) Over/Under Voltage Protection
- (viii) Directional Over current and Earth Fault protection
- (ix) Current reversal guard feature
- (x) Stub protection function
- (xi) Load encroachment blinder feature.
- (xii) Switch on to fault feature.
- (xiii) In built Broken Conductor detection feature.
- (xiv) Shall have df/dt functions
- (xv) Under frequency protection

(xvi) Main 1 and Main 2 relay shall of different **make and model**.

- **132 KV Line Panel**

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

a) Main Protection Scheme I:

Distance protection scheme using Numerical Relay as specified in Clause 14.15 and 14.16.2.

b) Backup Protection:

The backup protection shall be provided with directional single/ multi pole relays as specified in Clause 14.16.4. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults without high set elements shall be provided.

- **33KV Feeder Protection Panel**

The 33kV Feeder Panels shall be provided non directional single/ multi pole relays as specified in Clause 14.16.4. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided.

- **Power and Auto Transformer Protection Panel**

Integrated Transformer protection scheme as detailed in Clause 14.16.3 of the BID shall be provided for Panels for all Power and Auto Transformers:

(a) Main Protection -1

Biased transformer differential protection employing relay type specified in Clause 14.32. The scheme shall include also following:

- (i) Second and fifth harmonic restraint feature.
- (ii) The relay shall also provide Restricted Earth Fault Protection
- (iii) The scheme shall have suitable input and output for transformer auxiliary protection like Buchholz, oil temperature, winding temperature etc.
- (iv) Over-fluxing protection
- (v) The relay shall have Back up protection features i.e Directional over current and earth fault with high set element. The high set unit should not operate due to transformer in-rush current.

(b) Main Protection - 2

Protection function shall be same as Main Protection – I.

(c) Backup Protection: The backup protection shall be provided with Directional relays as specified in Clause 14.16.3. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided. The high set unit should not operate due to transformer in-rush current.

- **Bus Bar Differential Protection Panel:**

- The Bus Bar Protection shall be provided as detailed in Clause 14.17 of the BID for 400kV, 220kV and 132kV Voltage Level.

- **Reactor Protection Panel:**

The Reactor Protection shall be provided as detailed in Clause 14.16.5 of the BID.

8.29.0 RELAY MAINTENANCE TOOL KIT

MAINTENANCE TOOL KIT

- The bidder shall supply a complete maintenance tool kit set. The tool kit shall have generally current jack, card extender, card puller, required crimping tool, screw drivers, pliers etc.
- The tool kit shall contain test plugs, test leads, clips for maintenance and testing of relays supplied. Further detailing will be done during detail engineering.
- The Maintenance Tool Kit shall be of Universal type.

8.30.0 TESTS

- The supplier shall carryout all tests as per relevant standards as all associated equipment including relays, meters, instruments etc. The supplier shall submit all that reports to Employer for approval before despatching the control and relay panels. The Bidder shall also submit along with the bid type test reports for relays instruments, meters and other devices of the type and class being offered. Bidder has to submit KEMA test certificate for Numeric relay on interoperability compliance of IEC 61850 in general and GOOSE messaging and publishing in particular along with the bid.
- Control and relay panels shall be subjected to the following tests:
 - a. Mechanical operation test.
 - b. Verification of degree of protection.
 - c. High voltage test (2000 volts for 1 minute)
 - d. Electrical control interlock and sequential operation test.
 - e. Verification of wiring as per approved schematic.
 - f. Interoperability test as per IEC 61850 (interoperability with ABB, AREVA, SIEMENS, GE and SEL)

8.31.0 PRE-COMMISSIONING TESTS

- 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
 - (i). IR values of all circuits
 - (ii). Measurement of burden in CT & PT circuits
 - (iii). Primary current injection of CT circuits with connected burden
 - (iv). Energisation of PTs at suitable low voltage and measurement of PT inputs at all measuring points
 - (v). Secondary ac current injection of relays, dynamic testing of all numeric relays. Tracing of zone curves, limits. Checking of relay timings, inherent or set values. For this testing, the contractor shall bring 'Omicron' or equivalent test kit.
 - (vi). Testing of voltage related elements like directional element, over fluxing, over/ under frequency, over/ under voltage features, tracing of curves and checking limits of set values and associated timings
 - (vii). Checking of Boolean logic gates, BI/BO points of the numeric relays, checking conformity to specification and checking of set logics
 - (viii). Checking of stability and sensitivity of differential zones by suitably applying 3-phase low voltages and shorting of primary circuits. Measurements of voltage and current inputs to all relays.
 - (ix). Checking stability & sensitivity of bus differential relay zones by suitably injecting current
 - (x). Primary injection of REF connected CTs, measurements of relay inputs and checking of stability and sensitivity of REF scheme
 - (xi). Checking registration of event and disturbance records in the numeric relays and downloading

- (xii). Testing of carrier aided protection schemes and simulation with regard to transmission and receipt of protection signalling
- (xiii). Testing of AR schemes
- (xiv). Checking of healthiness of each dc circuit of panels
- (xv). Simulation of faults like Buchholz, OTI, WTI and other relays and checking of tripping of breaker and connected annunciation
- (xvi). Operation of master trip relays, tripping of breaker through each trip coil and checking of interlocks
- (xvii). Simulation of faults like low gas, air pressure and checking operation of interlocks. Checking anti pumping scheme of CB
- (xviii). Simulation to Check Checking of PT selection schemes
- (xix). Simulation to Check interlocks of all CB and isolator interlocks
- (xx). Simulation to Check annunciation of all events in BCU (Bay control unit) as well as SAS (Sub-station Automation System)
- (xxi). Simulation to Check of logic of BCU
- (xxii). Operation of tap changing of transformer through SAS
- (xxiii). 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, AEGCL. The tests will be witnessed and approved by him or by his authorized officers.

8.32.0 TECHNICAL DATA SHEET FOR THE RELAY AND CONTROL PANELS

- Features to be provided in various Relay and Control panels are indicated below. Description below are only indicative; the Contractor shall ensure that all items are included in their offer to complete the schemes described in the Specification whether such items are specifically mentioned or not.

400kV and 220kV Feeder Panels:

SL NO	ITEM	RATINGS AND PARTICULARS	
		400KV Panel with 1 1/2 Breaker Scheme	220KV Panel with Main I & Main II
I	II	III	IV
A	LINE PANELS		
1	Protection and relays:		
	(a) Distance Protection Scheme I	1 No.	1 No.
	(b) Distance Protection Scheme II	1 no	1 no
	(c) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(d) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coils per pole or phase)	Supervision for 6 trip coils (2 trip coils per pole or phase)
	(e) DC Supply healthy monitoring scheme for two separate DC source	2 No.	2 No.
	(e 1) DC Changeover Relay	2 Nos	2 Nos
	(f) AC Supply healthy monitoring scheme	1 No.	1 No.
	(g) High Speed Trip relay (1 & 3 pole)	2 sets.(each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)	2 sets.(each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)
	(h) PT-CVT Selection Schemewith PT1-PT2-CVT selection relay	1 Set. Complete Bus PT1-Bus PT2-CVT Selection	1 Set. Complete Bus PT1-Bus PT2-CVT Selection

Construction of 1 (one) no. of 132/33kV, 50MVA Transformer Bay (both LV & HV) along with related services at 132kV Baghjap GSS of AEGCL.

		Scheme	Scheme
	(i) Auxiliary relay, timer relay for healthiness of relays, auto reclose communication link etc.	As required (Can be function of BCU)	As required (Can be function of BCU)
	(j) Trip Transfer Relay	-	2 sets
	(j) Fault Recorder	1 set (shall be function of IED)	1 set (shall be function of IED)
	(k) Distance to fault locator	1 set (shall be function of IED)	1 set (shall be function of IED)
	(l) Under Voltage protection relay for isolator/earth switch Interlock	2 nos	2 nos
	(m) Over Voltage Protection Scheme	1 set (maybe function of IED)	1 Set (maybe function of IED)
2	Meters		
	(a) ABT tri-vector Meter (SAMAST Compliant) with TTB	1No	1No
3	Controls/ Status indication/ Annunciation		
	Bay control unit (IED)	1No. (Function of BCU/ SAS)	1No. (Function of BCU/ SAS)

132kV and 33kV feeder Panels:

SL NO	ITEM	RATINGS AND PARTICULARS	
		132 kV Panel with Main & Transfer Bus Scheme	33 kV feeder panel with single bus system
		V	VI
A	LINE PANELS		
1	Protection and relays:		
	(a) Distance Protection Scheme	1 No.	-.
	(b) Back up directional over current and earth fault scheme	1 Set	-
	(c) Back up non directional over current and earth fault scheme	-	1 set
	(d) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(e) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 2 trip coils	Supervision for 2 trip coils
	(f) DC Supply healthy monitoring scheme, for two DC source	2 No.	2 No.
	(f 1) DC Changeover	2 Nos	2 Nos
	(g) AC Supply healthy monitoring Scheme	1 No.	1 No.
	(h) High Speed Trip relay	2 No.	2 No.
	(h1) High Speed Trip Relay for LBB	1 No	1 No

	(i) Auxiliary relay, timer relay for healthiness of relays, auto reclose communication link etc.	As required (Can be function of BCU)	As required (Can be function of BCU)
	(j) Trip Transfer Relay	2 sets	2 sets
	(j) Line CVT-Bus PT selection relay	1 No	-
	(k) 33kV Incomer PT selection	-	-
	(l) Distance to Fault Locator	1 set (shall be function of IED)	-
	(m) Fault Recorder	1 set (shall be function of IED)	
	(l) Under Voltage protection relay for isolator/earth switch Interlock	2 nos (function of IED)	
	(m) Over Voltage Protection Scheme	1 set (maybe function of IED)	
2	Meters		
	(a) ABT tri-vector Meter (SAMAST Compliant) with TTB	1 No	1 No
3	Controls/ Status indication/ Annunciation		
	Bay Control Unit (IED with HMI)	1No. (Function of BCU/ SAS)	1No.

Transformer Protection Panels

SL NO	ITEM	RATINGS AND PARTICULARS			
		400/220/33 kV Transformer Panel	220/132 kV Transformer Panel	220/33 kV Transformer Panel	132/33kV Transformer Panel
		VII	VIII	IX	X
B	TRANSFORMER PANELS				
1	Protection and Relays:				
	(a) Differential Protection Scheme	2 No.	2 No.	2 No.	2 No.
	(b) Restricted Earth Fault Protection Scheme	(inherent High imp REF)	(inherent High imp REF)	(inherent High imp REF)	(inherent High imp REF)
	(c) Back up directional over current scheme and earth fault scheme for HV side.	Could be feature of relay	Could be feature of relay	Could be feature of relay	Could be feature of relay
	(d) Back up directional over current and earth fault scheme for M/LV Side.	Could be feature of relay	Could be feature of relay	Could be feature of relay	Could be feature of relay
	(e) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs	Can be function of BCU/IEDs	Can be function of BCU/IEDs

	(f) Over Fluxing Protection scheme	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
	(g) Overload protection scheme	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
	(g.1) Tertiary Side O/C and Open Delta Voltage Protection	1 set	1 set	-	-
	(h) Trip Circuit Supervision Relay Scheme for ascertaining pre and post-closing healthiness.	Supervision for 4/12 trip coils (2 trip coils per pole/ breaker on each side)	Supervision for 4/8 trip coils (2 trip coils per pole/ breaker on each side)	Supervision for 4/8 trip coils (2 trip coils per pole/ breaker on each side)	Supervision for 4 trip coils (2 trip coils per breaker on each side)
	(i) DC Supply healthy monitoring scheme	2 No.	2 No.	2 No.	2 No.
	(i1) DC Changeover Relay	2 No.	2 No.	2 No.	2 No.
	(j) AC Supply healthy monitoring scheme	1 No.	1 No.	1 No.	1 No.
	(k) High Speed Trip relay (HV Side)	2 No.	2 No.	2 No.	2 No.
	(l) High Speed Trip relay (MV/LV Side)	2 No.	2 No.	2 No.	2 No.
	(m) Trip Transfer Relay	2 sets	2 sets	2 sets	2 sets
	(m) PT Selection Scheme on HV / MV/LV Side as applicable	1 No. Complete Bus PT Selection Scheme (Can be function of BCU)	1 No. Complete Bus PT Selection Scheme (Can be function of BCU)	1 No. Complete Bus PT selection scheme (can be function of BCU)	1 No. Complete Bus PT selection scheme (can be function of BCU)
	(m1) PT Selection Relay	3 Nos for HV/ 2 Nos for LV	2 Nos for HV/ 2 No for MV	2 Nos for HV/ 2 No for LV	1 No for HV/ 2 No for LV
	(n) Tripping relay for Bucholtz, PRD, WTI, OTI, OSR etc.	As required	As required	As required	As required
	(o) Alarm auxiliary for Bucholtz, PRD, WTI, OTI, MOG, Air Cell leakage etc.	As required (Can be a function of BCU)	As required (Can be a function of BCU)	As required (Can be a function of BCU)	As required (Can be a function of BCU)
	(p) Transformer tap position status/ raise & lower	Can be a function of BCU	Can be a function of BCU	Can be a function of BCU	Can be a function of BCU
	(q) Reverse Power Protection	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
2	Meters				
	(a) ABT tri-vector Meter (SAMAST Compliant) With TTB	2 No. (on 400kV and 220 kV side)	2 No. (on 220 kV and 132 kV side)	2 No. (on 220 kV and 33kV side)	2 Nos. (132 kV & 33 kV side)
3	Controls / interlocks / Status indication/ Annunciation				

Bay Control Unit (IED), one no each for HV & LV side.	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)
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Reactor Protection Panel

The Reactor Protection Panel shall consist of following protection features/schemes:

SL. NO	Description	400 kV
		XI
1	Reactor Differential Protection scheme	1 No
2	Restricted Earth fault Protection scheme:	1 No
3	Reactor back up impedance protection scheme	1 Set
4	Three phase trip relays (Only for Bus Reactor)	2 Nos.
5	CVT selection relay as per scheme requirement	Lot

400kV, 220 kV and 132 kV Bus Coupler / Bypass Breaker Panel

SL NO	ITEM	RATINGS AND PARTICULARS	
		220 kV Panel with Main I & Main II Scheme	132 kV Panel with Main 1 & Transfer Bus Scheme
		XII	XIII
A	BUS COUPLER PANEL		
1	Protection and relays:		
	(a) Back up directional over current and earth fault scheme	1 Set	1 Set
	(b) Bus Bar differential protection	Main I and Main II	Applicable, where specified in BoQ
	(c) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(d) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coil for each Phase)	Supervision for 2 trip coils
	(e) DC Supply healthy monitoring	2 No.	2 No.

	scheme		
	(e) DC Changeover Relay	2 No.	2 No.
	(f) AC Supply healthy monitoring scheme	1 No.	1 No.
	(g) High Speed Trip relay	2 Sets. (each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)	2 No.
	(h) PT Selection Scheme	1No. Complete Bus PT Selection Scheme (Can be function of BCU)	Not applicable
	(i) Auxiliary relay, timer relay scheme	As required	As required
2	Metering	Function of BCU/ SAS	Function of BCU/ SAS
3	Controls/Annunciation/Status indication		
	Bay control unit (IED)	1 No. (Function of BCU/ SAS)	1 No. (Function of BCU/ SAS)

400kV Tie Breaker Panel

SL NO	ITEM	Ratings and Particulars
		4000 kV Panel with 1 ^{1/2} Breaker Scheme
		XIV
B	TIE PANEL	
1	Protection and relays:	
	(a) Back up directional over current and earth fault scheme	
	(b) Bus Bar differential protection	
	(c) LBB Relay.	1 No
	(d) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coils per pole or phase)
	(e) DC Supply healthy monitoring scheme	2 No.
	(f) DC Changeover Relay	2 No
	(f) AC Supply healthy monitoring scheme	1 No.
	(g) High Speed Trip relay	2Sets. (each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)
	(h) Auxiliary relay, timer relay scheme	As required
2	Metering	Function of BCU/ SAS
3	Controls/Annunciation/Status indication	
	Bay control unit (IED)	1 No.

8.33.0 Monitoring, Control & Protection for Auxiliary Transformer

Suitable monitoring, control (operation of associated Circuit breaker and isolator) and protection for LT Auxiliary Transformer, connected to tertiary winding of auto transformer for the purpose of auxiliary supply shall be provided by the contractor. Overcurrent and open delta protection is required to be provided for the auxiliary transformer. These control and protection shall also be acceptable as built in feature either in the bay controller to be provided for the auxiliary system or in the control and protection IEDs to be provided for the auto transformer.

NOTE: 1) The relays (main / auxiliary) not covered within the above table shall be considered for complete commissioning of the protection scheme.

2) In Case of incomplete Diameter (D and I type layouts), control panel shall be equipped fully as if the Diameter is complete, unless otherwise specified. Annunciation relays shall also be provided for the same and if required, necessary panel shall be supplied to accommodate the same.

3) Relay setting template (in editable document format) shall be provided by the Contractor for each typical protection IEDs for relay setting purpose.

4) For GIS Sub Stations, GIS Gas Zone trip signals, if provided, for each gas tight compartments (gas zone) in the GIS LCC shall be integrated in the protection schematics to provide electrical isolation of faulty Gas Zone by tripping/ inter tripping its adjacent circuit breakers. The scheme shall be implemented through protection IEDs and auxiliary relay as required.

SECTION-9

TECHNICAL SPECIFICATION FOR SUBSTATION AUTOMATION SYSTEM

9.1.0 General

The substation automation system shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned substation automation system ***which must be in satisfactory operation for at least 3 (three) years as on the date of bid opening.*** KEMA/ Internationally and nationally accredited certificate for all IEDs and Ethernet switches conforming to IEC 61850 is to be furnished as qualification requirement.

Standards

Environment Standards

All these standards are applicable to elements like HMI, Ethernet network and elements, Gateways, IEDs.

Type Test Name	Type Test Standard	Conditions
Insulation Resistance	IEC 60255-5	100 MΩ at 500 Vdc (CM & DM)
Dielectric Withstand	IEC60255-5 IEEE C37.90	50 Hz, 1mn, 2kV (CM), 1kV (DM)
		50 Hz, 1mn, 1kV (CM)
		G 1.4 & 1.5 500V CM G 6 :1,5 kV CM
High Voltage Impulse Test	IEC 60255-5	5kV (CM), 3kV (DM)
		2kV (CM)
		Groups 1 to 6 :5 kV CM & 3 kV DM(1)
		Not on 1.4 & 1.5 : 5 kV CM & 3 kV DM(1)
Free Fall Test Free Fall Packaging Test	IEC 60068-2-31 IEC 60068-2-32	Test Ec : 2 falls from 5cm Test Ed : 2 falls from 0,5m
		2 falls of 5 cm (Computer not powered)
		25 falls of 50 cm (1) (2) (Packaging computer)
Vibration Response – Powered On	IEC 60255-21-1	Class 2 : 1g from 2 to 150Hz
		Classe 2 : Acceleration : 1g from 10 (1) to 150Hz
Vibration Response – Not Powered On	IEC 60255-21-1	Class 2 : 2g from 2 to 500Hz
		Classe 2 : Acceleration : 2g from 10 (1) to 500Hz
Vibration Endurance – Not Powered On	IEC 80068-2-6	Class 2 : 1g from 10 to 150Hz
		Class 2 : Acceleration : 1g from 10 (1) to 500Hz

Type Test Name	Type Test Standard	Conditions
Shocks – Not Powered On	IEC 60255-21-2	Class 1 : 15g, 11 ms
Shocks – Powered On	IEC 60255-21-2	Class 2 : 10g, 11 ms
Bump Test – Not Powered On	IEC 60255-21-2	Class 1 : 10g, 16ms, 2000/axis
Seismic Test – Powered On	IEC 60255-21-3	Class 1 : Axis H : 3,5mm – 2g Axis V : 3,5mm – 1g
		Classe 2 : Acceleration : 2g Displacement : 7,5mm selon axe H Acceleration : 1g Displacement : 3,5mm selon axe V
Damp Heat Test - Operating	IEC 60068-2-3	Test Ca : +40°C / 10 days / 93% RH
Cold Test - Operating	IEC 60068-2-1	Test Ab : -10°C / 96h
		Test Ab : - 25°C / 96 H
Cold Test - Storage	IEC60068-2-1	Test Ad : -40°C / 96h Powered On at –25°C (for information) Powered On at –40°C (for information)
Dry Heat Test – Operating	IEC 60068-2-2	Test Bd : 55°C / 96h
		70°C / 2h
		70°C / 24 H
Dry Heat Test – Storage	IEC 60068-2-1	Test Bd : +70°C / 96h Powered On at +70°C
Enclosure Protection	IEC 60529	Front : IP=52 Rear : IP=30
Inrush current (start-up)		T < 1,5 ms / I < 20 A T < 150 ms / I < 10 A T > 500 ms / I < 1,2 In
Supply variation	IEC 60255-6	Vn +/- 20% Vn+30% & Vn-25% for information

Type Test Name	Type Test Standard	Conditions
Overvoltage (peak withstand)	IEC 60255-6	1,32 Vn max 2 Vn during 10 ms (for information)
Supply interruption	IEC 60255-11	From 2,5 ms to 1 s at 0,8 Vn 50 ms at Vn, no malfunction (for information)
40 s interruption	IEC 60255-11	
Ripple (frequency fluctuations)	IEC 60255-11	12% Vn at f=100Hz or 120Hz 12% Vn at f=200Hz for information
Supply variations	IEC 60255-6	Vn +/- 20%
AC Voltage dips & short interruptions	EN 61000-4-11	2ms to 20ms & 50ms to 1s 50 ms at Vn, no malfunction (for information)
Frequency fluctuations	IEC 60255-6	50 Hz : from 47 to 54 Hz 60 Hz : from 57 to 63 Hz
Voltage withstand		2 Vn during 10 ms (for information)
High Frequency Disturbance	IEC 60255-22-1 IEC 61000-4-12 IEEE C37.90.1	Class 3 : 2.5kV (CM) / 1kV (DM)
		Class 2 : 1kV (CM)
Electrostatic discharge	IEC 60255-22-2 IEC 61000-4-2	Class 4 : 8kV contact / 15 kV air
Radiated Immunity	IEC 60255-22-3 IEC 61000-4-3	Class 3 : 10 V/m – 80 to 1000 MHz & spot tests
	IEEE C37.90.2	35 V/m – 25 to 1000 MHz
Fast Transient Burst	IEC 60255-22-4 IEC 61000-4-4 IEEE C37.90.1	Class 4 : 4kV – 2.5kHz (CM & DM)
		Class 3 2 kV - 2,5 kHz MC
		Class 3 : 2kV – 5kHz (CM)
Surge immunity	IEC 61000-4-5	Class 4 : 4kV (CM) – 2kV (DM)

Type Test Name	Type Test Standard	Conditions
		Class 3 : 2kV (CM) on shield
		Class 4 : 4kV (CM) for information
		Class 3 : 1 kV MC
High frequency conducted immunity	IEC 61000-4-6	Class 3 : 10 V, 0.15 – 80 MHz
Harmonics Immunity	IEC 61000-4-7	5% & 10% de H2 à H17
Power Frequency Magnetic Field Immunity	IEC 61000-4-8	Class 4 : 50 Hz – 30 A/m permanent – 300 A/m short time
		Class 5 : 100A/m for 1mn 1000A/m for 3s
Power Frequency	IEC 61000-4-16	CM 500 V / DM 250 V via 0.1 μ F
Conducted emission	EN 55022	Gr. I, class A and B : from 0.15 to 30 MHz
Radiated emission	EN 55022	Gr. I, class A and B : from 30 to 1000 MHz, 10m

Communication Standards

UCA2:

CASM 1.6 - Common Application Service Models and Mapping to MMS

GOMSFE 0.91 - Generic Object Models for Substation & Feeder Equipment

IEC 61850:

IEC 61850-8-1: *Communication networks and systems in substations – Part 8-1: Specific communication service mapping (SCSM) – Mapping to MMS(ISO/IEC 9506 Part 1 and Part 2*

Telecontrol protocol:

IEC 608670-5-101

IEC 608670-5-104.

Legacy protection protocol

IEC 60870-5-103 *International standards – First release 1997-12*

MODBUS

Automation Standard

IEC 61131-3

The Substation Automation System (SAS) shall be installed, tested and commissioned to control and monitor all the sub-station equipment from remote control center (SCADA) as well as from local SCADA.

The SAS shall contain the following main functional parts:

- Bay control Intelligence Electronic Devices (IEDs) for Control and Monitoring.

- Bay Protection Intelligent Electronic device (IEDs) for Protection as detailed in previous chapter
- Metering server (Industrial Grade) and protocol converter.
- Station Main & Hot Standby Redundant Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- The managed Ethernet switch shall have sufficient port redundancy (Both Fibre & Copper ports).
- The IED shall have two fiber optic ports for connecting Ethernet Switch of each LAN i.e. (PRP,architecture).
- Integrated Switches (built-in bay IEDs) are not acceptable. All the IEDs shall be directly connected to the Ethernet Interbay LAN without the use of any gateways.
- Gateway for remote control via industrial grade hardware (to SLDC) through IEC60870-5-101 & 104 protocol. All the IEDs shall be directly connected to the Ethernet PRP LAN without use of any gateways.
- The communication protocol between the bays, with the Gateway and HMI shall be UCA2/IEC 61850 in order to permit 100 Mbps peer-to-peer communications.
- Within a bay it shall be UCA2/IEC 61850 protocol.
- All IEDs shall have redundant power card.
- Gateway for Control from Remote end and State Load Dispatch Center (SLDC). The gateway should be able to communicate with SLDC on IEC 60870-5-101 & 104 protocol. The specific protocol to be implemented shall be handed over to successful bidder. It shall be the bidder's responsibility to integrate his offered system with existing SLDC system for exchange of desired data. The bidder shall ensure that proposed automation system is compatible with the existing SCADA network. Equipment required for data transfer to the existing SCADA network to interface communication equipment is in the bidder's scope of work and it will be included in the bid price.
- Gateway shall also have redundancy and redundant Gateway shall not be housed in a single cabinet. The Gateway shall also have sufficient future expandability and this shall excludes data **for all future provision bays as per Project Requirement**. The Gateways shall have redundant power cards.
- The communication link (PLCC / Fiber Optic) to SLDC is not in the scope of the bidder. However, the bidder will provide required modem both for PLCC and Fibre Optic communications to the nearest Wide Band Locations of STU/CTU which are connected to SLDC. It shall be the bidder's responsibility to integrate the offered system for desired exchange of telemetry data to SLDC.
- Redundant Local HMI & DR Work Station.
- Peripheral equipment like printers, display units, key boards, Mouse etc. 3.4.1.5. It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.
- Gateway IEDs shall have redundant power card.
- Gateway shall also have 100% redundancy for it's all functions like power, AI & BI/BO card etc. The Gateway shall also have sufficient future expandability and this shall excludes **data for all future provision bays as per Project Requirement**. The Gateways shall have redundant power cards
- **License of 15 years for the commissioned Sub Station Automation System (SAS) shall be provided.**

- **Vulnerability Audit and Penetration Testing by CERT-In empanelled firm: After successful commissioning of SAS, the successful Bidder shall do cyber Audit of the system by a CERT-In empanelled Cyber Security Auditor (to be approved by AEGCL). For that the company shall do Vulnerability assessment and Penetration testing of the SAS system and submit the report to AEGCL. The company shall fix any vulnerabilities found during the VA/PT.**

It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. **A model architecture drawing for SAS is enclosed at the end of this chapter as Annexure I.**

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 Station Automation System through a **PRP** Ethernet LAN on fiber optic medium and shall communicate as per the IEC61850 standard.

The communication gateway shall facilitate the information flow with SLDC/Remote Control Centre.

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.

The Integration of IEC61850 communication based monitoring equipment like Online Insulating Oil drying system, Digital RTCC Relays etc with substation automation system shall be carried out and shall be included in the scope of work.

Further the Gateways shall have licenses sufficient for all the bays covered in the present scope as well as all the mentioned future bays.

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 SYSTEM DESIGN

General System Design

- The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including **all future extensions as per Project Requirement..**
- The systems shall be of the state-of-the art architecture and shall be suitable for operation under electrical environment present in Extra high voltage substations, follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.
- The offered SAS shall support remote control and monitoring from remote SCADA via gateways.
- The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

- The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signaling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.
- Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.
- **Bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated isolator, earth switches and instrument transformer), bay mimic along with relay and protection panels and Station HMI in Control Room building for overall optimization.**

9.3.0 Ethernet Switches

Ethernet switches that fulfill the hardened requirements concerning temperature, power supply (80-250 V DC from the Station Battery) **and complying to IEC 61850** suitable to be installed in substations shall be provided, i.e. the same data as common for numerical protection. **The Managed Ethernet Switch shall have dual Power supply provision.** The use of Ethernet Hubs is not permitted as they do not provide collision free transmission. Suitable port monitoring software shall be provided for monitoring of ports healthiness and should generate alarm in SAS.

9.4.0 SYSTEM ARCHITECTURE

- The SAS shall be based on a PRP architecture and on a concept of bay-oriented, distributed intelligence.
- The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level.
- At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers. But in case of Circuit Breaker SF6 Gas Pressure, Operating Mechanism Pressure (i.e. Air/ Pneumatic, Hydraulic and Nitrogen Pressures), if SF6 CTs are Utilizing the Pressure of SF6 Gas, Transformer Oil/ Winding temperatures, fire fighting or any Other with Transformer management Relay and OLTC Tap Position & Operation can be interfaced with BCU or any Other device interface through Transducers. The tap changing operation, synchronization of sources and trip transfer operation shall be performed through the BCU in addition to above. These parameters shall appear in Substation Automation System at Local HMI.

In GIS Sub Stations, all the gas tight chambers are required to be monitored individually phase wise for their SF6 gas density status by the bay control unit in a bay. Sufficient numbers of inputs are required to be provided in the BCU for the all the signals from the GIS Bays. In case there is any limitation of number of inputs in the BCU, additional BCUs or additional Cards(In case of Modular BCU) are required to be provided without any cost implication to AEGCL. These inputs shall be used for necessary monitoring, control and protection purpose.

The Sub-station Automation system being offered shall generally conform to provision of IEC 62351, IEEE1686 and NERC CIP (applicable part such as CIP 003, CIP-005, and CIP-007) for cyber security.

- **Tagging for Report generation shall be provided for sufficient number of signals for incorporation of all present and future bays, including 20% spare.**
- Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

- The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fiber optic cables, thereby guaranteeing disturbance free communication. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.
- The communication shall be in parallel mode, and such that failure of one set of fiber shall not affect the normal operation of the SAS. However, it shall be alarmed in SAS. Each fiber optic cable shall have four (4) spare fibers. IED shall have two fibre ports and one port shall be connected to individual Ethernet Switch of each LAN.
- At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.
- Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. RCC, station HMI, bay level or apparatus level. **The priority shall always be on the lowest enabled control level.**
- The station level contains the station-oriented functions, which cannot be realized at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centers.
- The GPS time synchronizing signal for the synchronization of the entire system with redundancy shall be provided.
- The SAS shall contain the functional parts as described in para above.

9.5.0 FUNCTIONAL REQUIREMENTS

The high-voltage apparatus within the station shall be operated from different places:

- ✓ Remote control centers/SLDC
- ✓ Station HMI.
- ✓ Local Bay controller IED

Operation shall be possible by only one operator at a time.

The operation shall depend on the conditions of other functions, such as interlocking, synchro check etc.

Select-before-Execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

Command Supervision

Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

Run Time Command Cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

Self-supervision

Continuous self-supervision function with self-diagnostic feature shall be included.

User Configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-in functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

The Functional requirement shall be divided into following levels:

- a). Bay (a bay comprises of one circuit breaker and associated disconnecter, earth switches and instrument transformer) Level Functions
- b). System Level Functions

9.6.0 BAY LEVEL FUNCTIONS

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control functions **including data collection in bay control / protection unit.**
- Bay protection functions with support of Numerical Relays defined in CRP Section.

9.7.0 Bay Control Functions

Overview

Functions:

- Control mode selection
- Select-before-execute principle
- Command supervision:
 - ✓ Interlocking and blocking
 - ✓ Double command
- Synchro-check, voltage selection
- Run Time Command cancellation
- Transformer Tap Changer control (raise / lower tap) (for Power Transformer bays)
- Operation counters for Circuit Breakers and Pumps.
- Transformer cooling gear, pump control and runtime supervision
- Operating pressure Monitoring & supervision (CB SF6 Gas Pressure, CB Operating Pneumatic Pressure / spring status).
- Display of interlocking and blocking
- Breaker position indication (per phase for single pole)
- Alarm annunciation
- Measurement display. (Electrical Parameters & Transformer Parameters)
- Local HMI (local guided, emergency mode)
- Interface to the station HMI.
- Data storage for at least 500 events
- Extension possibilities with additional I/O's inside the unit or via fiber optic communication and process bus

Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

REMOTE mode

Control authority in this mode is given to a higher level (Remote SCADA) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

- Settable voltage, phase angle, and frequency difference.
- Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchro-check function.
- Synchronizing between live line and live bus with synchro-check function

Voltage selection

The voltages relevant for the Synchro-check functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the bay control and protection IEDs.

Transformer Tap Changer control

Raise and lower operation of OLTC taps of Transformer shall be facilitated through Bay controller IED.

Protection Transfer Control

From BCU, necessary control shall be provided for transferring bay to TBC.

9.8.0 Bay Protection Functions**General**

The Protection functions are independent of Bay Control function. The Protection shall be provided by separate Protection IEDs (numerical relays) and other Protection devices as per section Relay & Protection.

IEDs shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as detailed in section C&R.

Bay Monitoring Functions

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit.

9.9.0 SYSTEM LEVEL FUNCTIONS

Status Supervision

- Continuous monitoring of switching objects i.e. the position of each switchgear, e.g. Circuit Breaker, Isolator, Earthing Switch, Transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station
- HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.
- The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.
- The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through dedicated one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

Measurements

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms, Max / Min values for voltage (U) and current (I) shall be calculated.

In case of Circuit Breaker SF6 Gas Pressure, Operating Mechanism Pressure (i.e. Pneumatic, Spring), if SF6 CTs are Utilizing the Pressure of SF6 Gas, Transformer Oil/ Winding temperatures, Firefighting or any Other with Transformer management Relay and OLTC Tap Position can be interfaced with BCU through Transducers. Max / Min values for the above parameters shall be calculated. These parameters shall appear in Substation Automation System at Local HMI and can monitor regularly.

The measured values shall be displayed locally on the station HMI and in the control center. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds.

Threshold limit values shall be selectable for alarm indications.

The SAS shall also poll data from the Meter Server to gateway for onward communication to RCC.

Event and alarm handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms. **The tentative list of event/ alarm for various feeders and systems are enclosed as Annexure-II and is not exhaustive, there may be addition during detail engineering or at the time of commissioning.**

9.10.0 Station HMI

Substation HMI Operation:

On the HMI the object has to be selected first. In case of a blocking or interlocking condition are not met; the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

Presentation and dialogues

General

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI:

- ✓ Single-line diagram showing the switchgear status, Pressure values (wherever required) and measured values (current, voltage, apparent power, freq & pf) including OLTC Tap Position, WTI, OTI & Analog set values.
- ✓ Control dialogues with interlocking and blocking details. This control dialogue shall tell the operator whether the device operation is permitted or blocked & Select before Execute.
- ✓ Measurement dialogues, Statistics & Trends
- ✓ Bay wise interlock status display and failure of any interlock within the bay by generating alarm and indication in Interlock diagram window.
- ✓ Alarm list, station / bay-oriented
- ✓ Event list, station / bay-oriented
- ✓ Substation Auxiliaries
- ✓ System status
- ✓ Printing of sequence of event list, hardcopy and reports. The reports shall be freely configurable using Crystal Report

List of signals to be configured in SAS is mentioned in Annexure-II of this chapter.

HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

- ✓ Selected object under command
- ✓ Selected on the screen
- ✓ Not updated, obsolete values, not in use or not sampled
- ✓ Alarm or faulty state
- ✓ Warning or blocked
- ✓ Update blocked or manually updated
- ✓ Control blocked
- ✓ Normal state

Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In addition to above Transformer WTIs, OTI, SF6 gas Pressures of Circuit breakers, CTs and CB Operating mechanism Pressures shall also be displayed.

In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able

to recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the “execution” of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

System Supervision and Display

The SAS system shall be comprehensively self-monitoring such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure, protection couplers and remote communication links, and printers at the station level, etc.

Event List

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with 1ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer/Dot matrix Printer / Line Printer of 132 Column.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

- Position changes of circuit breakers, isolators and earthing devices
- Indication of protective relay operations
- Fault signals from the switchgear
- Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurand.
- Loss of communication.
- Hourly time Stamping

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- Date and time
- Bay
- Device
- Function e.g. trips, protection operations etc.
- Alarm class

Alarm List

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm

tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

- The date and time of the alarm
- The name of the alarming object
- A descriptive text
- The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent). Filters for selection of a certain type or group of alarms shall be available as for events.

Object picture

When selecting an object such as a circuit breaker or isolator in the single line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

- Type of blocking
 - Authority
 - Local / remote control
 - SLDC / SAS control
 - Errors
- etc. shall be displayed.

Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

- Breaker and Disconnecter
- Transformer tap-changer

User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorization group. Each user shall then be given access rights to each group of objects, e.g.:

- Display only
- Normal operation (e.g. open/close of switchgear), Shift wise operator's pass word for 3 shift in a day.
- Restricted operation (e.g. by-passed interlocking)
- System administrator
- For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:
 - No engineering allowed
 - Engineering/configuration allowed
 - Entire system management allowed

The access rights shall be defined by passwords assigned during the login procedure. Only the system administrator shall be able to add/remove users and change access rights.

9.11.0 Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

Trend reports:

- Day (mean, peak)
- Month (mean, peak)
- Semi-annual (mean, peak)
- Year (mean, peak)
- Historical reports of selected analogue Values:
- Day (at 15 minutes interval)
- Week
- Month
- Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

Following printouts shall be available from the printer and shall be printed on demand:

- i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
- ii. Weekly trend curves for real and derived analogue values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
- v. Equipment operation details shift wise and during 24 hours.
- vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperatures (WTIs, OTI) and status of pumps and fans for transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
- viii. Reports in specified formats which shall be developed by the contractor.

Trend Display (historical data)

It shall be possible to illustrate all types of process data as trends – input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

Automatic Disturbance File Transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

Disturbance Analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

IED Parameter Setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

Automatic Sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

9.12.0 GATEWAY

Communication Interface

The Substation Automation System shall have the capability to support simultaneous communications with SLDC,

The Substation Automation System shall have communication ports as follows:

(a) Two Ports for RCC & State Load Dispatch Centre from each Gateway.

(b) The redundant Gateway shall work as hot stand by.

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centers (SLDC).

SLDC Communication Interface

Employer will supply communication channels between the Substation Automation System and the SLDC. The communication channels provided by Employer will consist either of power line carrier or optical fiber.

Interface equipment:

The Contractor shall provide interface equipment for communicating between Substation Automation system and State Load Dispatch Centre (PLCC/ FO).

In case of PLCC communication any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. **The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel.** The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and SLDC.

Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-101,104 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc.

9.13.0 SYSTEM HARDWARE

Redundant Station HMI, and Disturbance Recorder Work station).

The contractor shall provide redundant station HMI in hot standby mode. **The servers used in these work stations shall be of industrial grade.**

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features. The RAM, Hard Disk and Bus should latest and with maximum Values.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1) Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event and trend data for thirty (30) days,

- 2) Storage of all necessary software,
- 3) 500GB space for EMPLOYER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

HMI (Human Machine Interface)

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user-friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

For 400kV, 220kV, 132kV Substations 70mm VDU high resolution screen showing total SLD, alarm, bay wise real time data to be displayed as shown in the model SAS architecture.

Visual Display Units/TFT's (Thin Film Technology)

The contractor shall provide three display units, one for station HMI, one for redundant HMI and one for DR work station. These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 25" diagonally (3:4) in size or more and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixels or more.

Printer

It shall be robust & suitable for operation with a minimum of 132 characters per line for Line Printer and Dot Matrix Printer. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All printers mounted in the control room shall be provided with printer enclosure. The enclosure shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading. The printer enclosures shall be designed to protect the printers from accidental external contact & each should be removable from hinges at the back and shall be provided with lock at the front.

All reports and graphics prints shall be printed on **laser printer**

One Dot Matrix Printer (DMP) shall be exclusively used for hourly log printing.

Line printer for Events and Alarms Printing

All printers shall be continuously online through directly or printer server.

Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values, and indications shall be stored in a mass-storage unit of CD-ROM & DVD-ROM with 5GB or more capacity i.e CD Writer & DVD Writer (Both). The unit should support at least Read (48X), Write (24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rockridge and Joliet File systems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

All the data pertaining to Substation is to store in a system year/ month / day wise. The daily data is stored in a day file of Particular Month and Year automatically from 00.00Hrs to 24.00Hrs.

Auxiliary BCU

One BCU shall be put in Station level for monitoring Station Auxiliary Supply (AC & DC), Battery Chargers, Nitrogen Fire Fighting System, Fire alarm etc.

Furniture required for HMIs, Printers, and Operators etc. The make of furniture shall be of Godrej or better.

9.14.0 EXTENDIBILITY IN FUTURE

Offered substation automation system shall be suitable for extension in **future for all Future Bays as per Project Requirement**. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future..

9.15.0 SOFTWARE STRUCTURE

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder shall not force a shut-down of the parts of the system which are not affected by the system adaptation.

9.16.0 Station Level Software

Human-Machine Interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

9.17.0 Bay Level Software

System Software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronising with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library. The application software within the control/protection devices shall be programmed in a functional block language.

Simulation

Simulation tools shall be provided with the system to emulate a missing equipment on UCA2/IEC61850.

The simulation tools shall be set up by the system configuration tool and be able to execute scenario defined by the user.

9.18.0 Network Management System

The contractor shall provide a network management system software for following management functions:

- a. Configuration Management
- b. Fault Management
- c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

- (a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- (b) Maintain a graphical display of SAS connectivity and device status.
- (c) Issue alarms when error conditions occur
- (d) Provide facility to add and delete addresses and links

The bidder shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

9.18.1 Cyber Security features

wherever applicable All Intelligent electronic equipment, Numerical relays, Bay control units, Bay protection units, Gateways, Transformer Tap controller/changer, etc. with IEC 61850 communication protocol shall be cyber security compliant as per latest "CEA (Cyber security in power sector) Guidelines". Specifications shall also be compliant to latest revision of IEEE 1686

9.19.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV substation equipment and specified conditions:

Type Tests:

Control IEDs and Communication Equipment:

a. Power Input:

- i. Auxiliary Voltage
- ii. Current Circuits
- iii. Voltage Circuits
- iv. Indications

b. Accuracy Tests:

- i. Operational Measured Values
- ii. Currents
- iii. Voltages
- iv. Time resolution

c. Insulation Tests:

- i. Dielectric Tests
- ii. Impulse Voltage withstand Test

d. Influencing Quantities

- i. Limits of operation
- ii. Permissible ripples
- iii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

- i. 1 MHZ. burst disturbance test
- ii. Electrostatic Discharge Test
- iii. Radiated Electromagnetic Field Disturbance Test

- iv. Electrical Fast transient Disturbance Test
- v. Conducted Disturbances Tests induced by Radio Frequency Field
- vi. Magnetic Field Test
- vii. Emission (Radio interference level) Test.
- viii. Conducted Interference Test

f. Function Tests:

- i. Indication
- ii. Commands
- iii. Measured value Acquisition
- iv. Display Indications

g. Environmental tests:

- i. Cold Temperature
- ii. Dry Heat
- iii. Wet heat
- iv. Humidity (Damp heat Cycle)
- v. Vibration
- vi. Bump
- vii. Shock

Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

Integrated Testing

The integrated system tests shall be performed as detailed in subsequent clauses as per following configuration:

- Redundant Station HMI, DR work station, two switches (i.e. for two diameter) along with all IEDs for the Dia and printers.

All other switches for complete sub-station shall be simulated as needed.

Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period.

The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

Site Acceptance Tests:

The site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software. **The successful bidder shall submit the detailed SAT procedure and SAT procedure shall be read in conjunction with the specification.**

9.20.0 SYSTEM OPERATION

Substation Operation

NORMAL OPERATION

Operation of the system by the operator from the remote SLDC or at the substation shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse). The coloured screen shall be divided into 4 fields :

- i) Message field with display of present time and date
- ii) Display field for single line diagrams
- iii) Navigation bar with alarm/condition indication
- iv) Real time bus energization status with distinguishable colours i.e. for live & dead section of SLD.

For display of alarm annunciation, lists of events etc a separate HMI View node. shall be provided. All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between:-

- Prompting of indications e.g. fault indications in the switchgear, and
- Prompting of operational sequences e.g. execution of switching operations

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

9.21.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220/110V DC system.

Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown and restart.

9.22.0 DOCUMENTATION

The following documents shall be submitted for employer's approval during detailed engineering:

- (a) System Architecture Drawing
- (b) Hardware Specification
- (c) Sizing Calculations of various components
- (d) Response Time Calculation
- (e) Functional Design Document
- (f) Clear procedure describing how to add an IED/ bay in future covering all major suppliers

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look / feel. All CAD drawings to be provide in "dxf" format and also acrobat format.

- List of Drawings
- Substation Automation System Architecture
- Block Diagram
- Guaranteed Technical parameters, Functional Design Specification and Guaranteed availability and reliability
- Calculation for power supply dimensioning
- I/O Signal lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- Control Room Lay-out
- Test Specification for Factory Acceptance Test (FAT)
- Product Technical Manuals
- Application Manuals
- Assembly Drawing
- Operator's Manual
- Testing and Commissioning Manuals
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering

Two sets of hard copy and Four sets of CD ROM containing all the as built documents/drawings shall be provided.

9.23.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

Training at Contractor's Premises

The contractor shall arrange on its own cost all hardware and software training platform required for successful training and understanding in India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer. The contractor shall provide training comprehensively covering following courses.

S. No.	Name of Course	Participants from Employer	Duration
1	Computer System Hardware	2 per sub-station	7 day
2	Computer System Software	6 per sub-station	7 day
3	Application Software	2 per sub-station	7 day

A. Computer Hardware Course: The course will contain configuration of system hardware,

equipment maintenance and diagnostic procedure of each element of the SAS including modems, routers, processors, technique for system expansion, and maintenance of IEDs. It will be a hands-on training.

B. Computer System Software Course: The course will cover programming language, OS software, network software, database software, system configuration, development of logic circuits. This will also be a hands-on training

C. Application Software: It will also be a hands-on training and the course will contain application software and data flow, associated maintenance and expansion training, preparation and integration of new software etc.

Training offered shall be free of cost to the Employer except the logistic.

On Site Training:

After successful commissioning of the entire SAS, the contractor will impart on-site training in following areas:

S. No.	Name of Course	Participants from Employer	Duration
1	Computer System Hardware	2 per sub-station	7 day
2	Computer System Software	6 per sub-station	7 day
3	Application Software	2 per sub-station	7 day

Hands on training logic development, system configuration for extension of addition of bay, IED fault finding, trouble shooting, data analysis, changing of equipment parameters/ input data, preventive maintenance of each equipment

The site training will be also of similar nature as outlined in the previous clause, except that here the training will be on actual commissioned system and all aspects shall be covered. The training shall be conducted at each substation separately, covered in the package.

The Contractor shall submit the training modules for approval of the Employer. The training durations mentioned above is tentative only. Actual duration of the training shall be as per approved training module.

9.24.0 MAINTENANCE

Maintenance Responsibility during Pre-Commissioning and Commissioning Activities

During Pre-Commissioning and Commissioning activities, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

Maintenance Responsibility during Guarantee Period

During guarantee period as specified in tender document, contractor shall arrange bi-monthly visit of their representative to site to review the performance of system and in case any defect/shortcoming etc. is observed during the period, the same shall be set right by the contractor within 15 days free of any charge to the Employer.

9.25.0 RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well-tested hardware

- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
- Experience of security requirements
- Process know-how
- Select before execute at operation
- Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel grounding immune against transient ground potential rise

Outage terms

1) Outage

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause above due to an event directly related to the SAS or unit of SAS. In the event, the Employer has taken any equipment/ system other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

3) Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

4) Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period $AOH = \sum AOD$

5) Availability

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

9.26.0 GUARANTEES REQUIRED

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole during the pre-commissioning and commissioning periods. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 700 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 700 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the

guarantee period shall start along with the whole facilities.

9.27.0 SPARES

Consumables

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the Employer.

Availability Spares:

In addition to mandatory spares as listed in below for SAS, the bidder is required to list the recommended spares along with unit prices, which may be required for ensuring the guaranteed availability of the system. During the entire guarantee period including the pre-commissioning and commissioning periods, the successful contractor will have to make available at site his recommended spares.

Based on the requirement of recommended spares during the entire guarantee period, the Employer will decide the final list of spares that the Employer will procure for safe running of the system after the guaranteed period. The contractor is bound to supply these spares promptly.

LIST OF MANDATORY SPARES

- (a) FO cables with terminations for each type and length between IEDs (One FO cable for each type/length).
- (b) Patch/Cu cable with terminations of each type and length between IEDs of Station level (One cable for each type/length)
- (c) Any interface/Protocol converter (One for each type).
- (d) BI/BO card for each type of IED (one no each).
- (e) Power card for each type of IED (one no each).
- (f) Transducers of each type (one no each)
- (g) Industrial grade computer. (one number)

9.28.0 Major Component of SAS

Following minimum equipment shall comprise the Substation Automation System.

- i) Station HMI & Redundant Station HMI (in Hot-stand by mode) of Latest Configuration and Latest OS Software with CD & DVD Multilayer Read, write, Rewrite with Possible all types of formats, Hard disk capacity of 1TB, Key Board, Optical Mouse, integrated VGA, Integrated LAN, 25" or More TFT Monitor (4:3 Screen).
- ii) Engineering Station & Disturbance Recorder Work Station (Maintenance HMI)
- iii) Gateways with PLCC/Fibre Optic Modem
- iv) Required Inverter/UPS for 3 hour back up
- v) List of Printers with / without Printer server
 - 1. Colour Laser Printer– 1 No. (Print, Scan, Fax & Xerox) (For Reports & Disturbance records),
 - 2. Line Printer - (For Alarms and Sequence of Event recorder)
 - 3. Dot matrix printer Multi sheet paper Model – For log sheets, regular parameters at 15 min duration).
- vi) All interface equipment for gateway to SLDC.
- vii) Communication infrastructure between Bay level units, Station HMI, Printers, gateways, redundant LAN etc. as required. (Armoured FO and Cu Cables) as required.
- viii) BCUs for Sub Station Auxiliaries.
- ix) Any other equipment as necessary.

For all the SAS equipment, the power supply unit shall have dual mode i.e. main & redundant card, in case of any one card fail, the IED/Component of SAS shall have to switch over to redundant card and to generate alarm for the outage of the card.

All the type of cables used for LAN (Bay level & Station level) shall be Armoured type.

9.29.0 Erection, Testing & Commissioning

- a) The bidder shall depute their Engineer to the various sites for carrying out the testing and commissioning of C&R panel.

9.30.0 GUARANTEES REQUIRED

The availability for the complete SAS shall be guaranteed by the Contractor.

The Guarantee period will be stipulated for 1 year and beyond which Annual Maintenance Contract (AMC) will come into force.

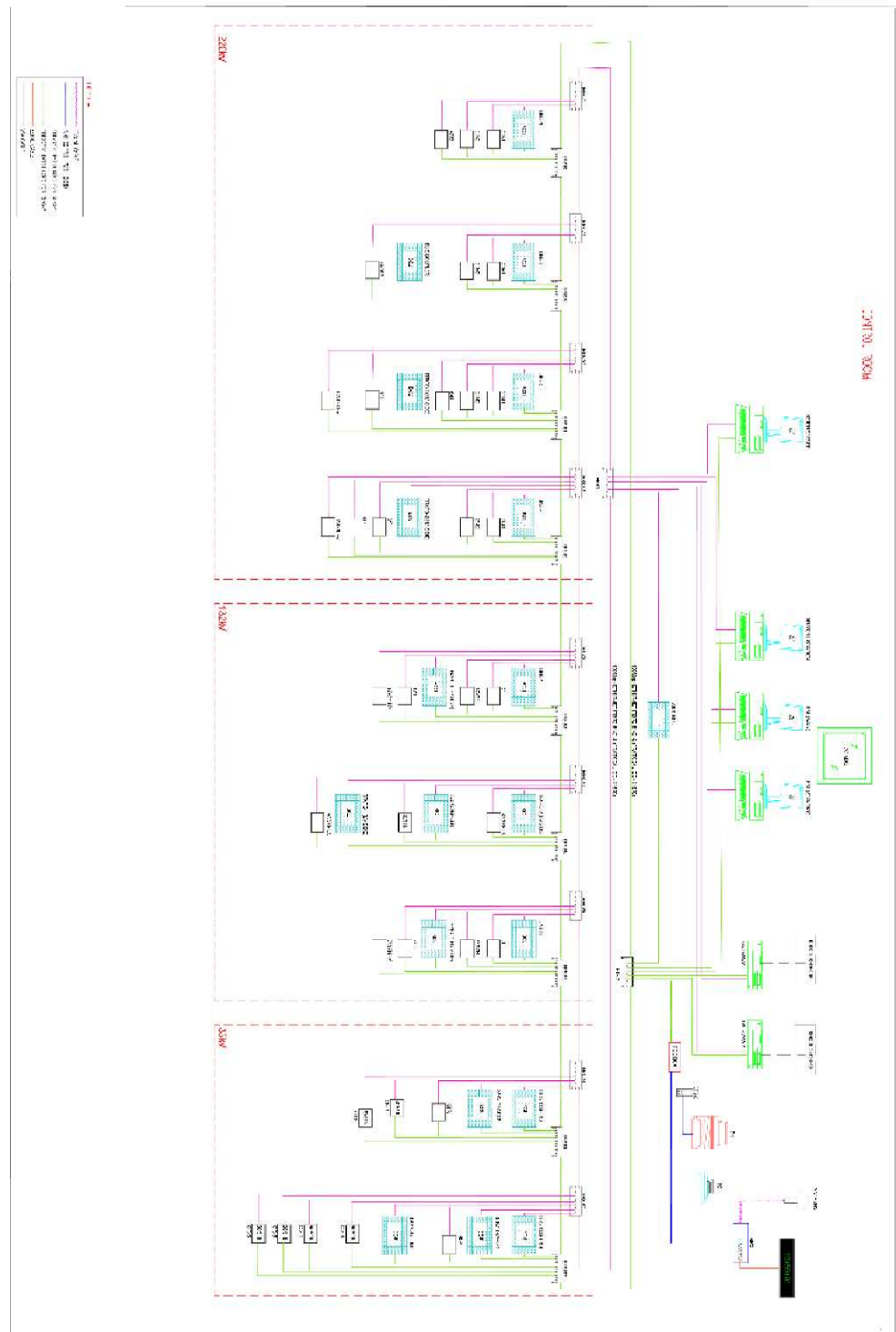
Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole during the pre-commissioning and commissioning periods. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 700 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 700 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start along with the whole facilities.

AMC shall be started after warranty period is over. During AMC, Manufacturer Engineer shall have to visit half yearly or as and when defects are developed. For any defects developed, Engineers are to attend the defects within three (3) working days of reporting. **The entire cost incurred for attending the issues raised/the regular yearly, half yearly visits shall be covered under the AMC. Manufacturer has the responsibility to take care of replacement of all items if required to restore the system.** During AMC, if any element is added up, integration of same is the responsibility of Manufacturer without any cost involvement to Employer.

ANNEXURE-I: SAS Architecture



Notes:

- 1) The redundant managed bus shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
- 2) The IEDs for control, protection & metering (ABT compliant electronic TVM) shall be installed in the swing type simplex C & R panels inside the control room, all connections shall be realized as per IEC 61850 protocol.
- 3) Required Inverter of Numeric make, 3 KVA capacity shall be provided by the bidder.
- 4) Necessary furniture for installation of complete equipment of SAS is also in the scope of supply. The successful bidder shall submit list of complete furniture including enclosure for printers.**
- 5) For gateway, it shall communicate with Remote Control Centre and State Load Despatch Centre (SLDC) on IEC 60870-5-101 & 104 protocol.
- 6) The SLD displayed in the HMI shall be capable of distinguishing the Bus for different voltage level, bus live & dead status, bay equipment live & dead status and future extension indicating through different colours.
- 7) The printers shall be connected to station bus directly and can be managed from station HMI, as well as disturbance recorder work station.

The above Architecture is typical. The contractor is to consider the SLD of respective substation for detail BoQ, particularly for Ethernet Switches & BCUs.

ANNEXURE II

List of Analogue and Digital Inputs/ Outputs for SAS

1. Basic Monitoring requirements are:

- o Switchgear status indication
- o Measurements (U, I, P, MVA, Q, f, sequence components, pf, phase angle, THD & TDD, Synchrocheck information i.e. ΔF , ΔV , $\Delta \phi$; Active & Reactive energy)
- o Event
- o Alarm
- o Winding temperature if transformers/ reactors
- o Ambient temperature
- o Status and display of station auxiliary ac & dc supply
- o Status display of transformer fire protection system
- o Acquisition of all counters in PLCC panels
- o from PLCC or independently by counting the receive/send commands
- o Acquisition of alarm and fault record from protection relays
- o Disturbance records
- o Monitoring the state of batteries by displaying DC voltage, charging current and load current etc for both 220/110-volt station & communication 48-volt batteries
- o Tap-position of Transformer

2. List of Inputs: The list of input for typical bays is as below:-

1) Analogue inputs

- For line R, Y, B phase line currents & R-N, Y-N, B-N phase voltages
- For transformers $\square \square$ R, Y, B phase line currents for HV & LV
 - OTI & WTI
 - Tap position
- For bus coupler R, Y, B phase line currents
- Common
 - R-N, Y-N, B-N phase voltages for all buses
 - Frequency of all buses
 - Outside ambient temperature

- LT ac voltages
- 220/ 110-volt station battery voltage
- 48-volt battery voltage

2) Digital inputs

➤ Line bays

- Status of each pole of CB
- Status of isolator, earth switch
- CB trouble
- CB operation / closing lock out
- Pole discrepancy operated
- Trip circuit faulty
- LBB operated
- Bus bar protection trip operated
- Breaker auto reclosure operated
- Tie/ transfer breaker auto reclosure operated
- AR lock out
- Trip transfer sent/ received
- Main I / II DPR operated
- Directional E/F operated
- Fuse failure alarm
- PSB alarm
- Broken Conductor alarm
- Under voltage alarm
- SOTF trip
- Carrier aided trip
- Main I/ II Zone 2/ Zone III trip
- Back up O/C or E/F operated
- PLCC protection channel I/ II failed
- PLCC speech failed
- BCU/ BPU failed

➤ Transformer bays

- Status of CB, isolator, earth switch
- CB trouble
- CB operation/ closing lock out
- Pole discrepancy operated
- Trip circuit I/ II faulty
- BCU/ BPU failed
- LBB operated
- Bus bar protection operated
- REF operated
- Differential operated
- Over flux alarm/ trip
- OTI/ WTI alarm/ trip
- Buchholz alarm/ trip
- OLTC OSR trip
- Low oil alarm
- PRD I/ II operated
- Back up O/C or E/F operated
- Zero sequence current
- Discrimination of PT fuse fail and circuit dead

- Bus bar Protection
 - Bus bar main I/ II trip
 - Bus bar zone I/II open
 - Bus protection relay fail
 - BCU/ BPU failed

Other Signal to be incorporated in DR/SAS:

Standard DR Signal

1. For transmission Line (One & half breaker scheme)

	MAIN-1	-
A	Configuration of ANALOG CHANNELS	
S.No.	Channel Description	Standardized Channel Name
1	R Phase Current	I-R PH.
2	Y Phase Current	I-Y PH.
3	B Phase Current	I-B PH.
4	Neutral Current	I-N PH.
5	R Phase Voltage	V-R PH.
6	Y Phase Voltage	V-Y PH.
7	B Phase Voltage	V-B PH.
8	Open Delta Voltage	V-N (Open Delta)

B	Configuration of Digital Channels for 32 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M CB_RO	Y	
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M CB_YO	Y	
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M CB_BO	Y	
4	TIE CB R-PHASE OPEN	TIE_CB_R_OPEN	T CB_RO	Y	
5	TIE CB Y-PHASE OPEN	TIE_CB_Y_OPEN	T CB_YO	Y	
6	TIE CB B-PHASE OPEN	TIE_CB_B_OPEN	T CB_BO	Y	
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y	
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y	MAIN-2
9	AUTO RECLOSE OPTD MAIN CB	MAIN_CB_A/R_OPTD	M CB_AR	Y	
10	MAIN CB AR LOCKOUT	MAIN_CB_AR_LO	MCB_AR_LO	N	
11	AUTO RECLOSE OPTD TIE CB	TIE_CB_A/R_OPTD	T CB_AR	Y	
12	TIE CB AR LOCKOUT	TIE_CB_AR_LO	AR_L/O	N	
13	MAIN1/2 CARRIER RECEIVE	MAIN1/2_CARR_REC	M1/2_CR	N	MAIN-1/2
14	DT RECEIVE CHANNEL-1/2	DT_REC_CH1/2	DTRC1/2	Y	
15	3 PH. GROUP A/B OPERATED	3PH_GR_A/B_OPTD	GRA/B_OPD	Y	
16	OVER VOLTAGE STAGE-1 OPERATED	O/V_STG1_OPTD	O/V_ST1	Y	

B Configuration of Digital Channels for 32 channels					
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
17	OVER VOLTAGE STAGE-2 OPERATED	O/V_STG2_OPTD	O/V_ST2	Y	
18	POWER SWING BLOCK OPERATED	PS BLK OPTD	PSB_OP	N	
19	STUB/TEED OPERATED	STUB_OPTD	SB_OPD	Y	Where ever Applicable
20	BUSBAR OPERATED (M1/M2)	BUSBAR_OPTD	BB_OPD	Y	
21	MAIN/TIE LBB OPERATED	M/T_LBB_OPTD	M/T_LBB	Y	
22	MAIN 1 ZONE-1 OPTD.	MAIN1_Z1_OPTD	M1Z1_OP	Y	
23	MAIN 1 ZONE-2 START	MAIN1_Z2_START	M1Z2_ST	N	
24	MAIN 1 ZONE-2 OPTD.	MAIN1_Z2_OPTD	M1Z2_OP	Y	
25	MAIN 1 ZONE-3 START	MAIN1_Z3_START	M1Z3_ST	N	
26	MAIN 1 ZONE-3 OPTD.	MAIN1_Z3_OPTD	M1Z3_OP	Y	
27	MAIN 1 REVERSE ZONE OPTD	MAIN1_ZR_OPTD	M1ZR_OP	Y	
28	MAIN 1/2 SOTF OPTD	M1/2_SOTF_OPD	M12SOTF	Y	
29	MAIN 1/2 DEF OPTD	DEF_OPD	DEF_OPD	Y	MAIN-1/2
30	MAIN1/2 CARR. SEND	M1/2 CARR. SEND	M12CRSD	N	MAIN-1/2
31	DIRECT TRIP SEND	DIR_TR SEND	DT_SEND	Y	
32	CARRIER AIDED TRIP	CARR_AID_TRIP	CAR_AID	Y	

MAIN-2		
A	Configuration of ANALOG CHANNELS	
S.No	Channel Description	Standardized Channel Name
1	R Phase Current	I-R PH.
2	Y Phase Current	I-Y PH.
3	B Phase Current	I-B PH.
4	Neutral Current	I-N PH.
5	R Phase Voltage	V-R PH.
6	Y Phase Voltage	V-Y PH.
7	B Phase Voltage	V-B PH.
8	Open Delta Voltage	V-N (Open Delta)

B Configuration of Digital Channels for 32 channels					
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M CB_RO	Y	
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M CB_YO	Y	
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M CB_BO	Y	
4	TIE CB R-PHASE OPEN	TIE_CB_R_OPEN	T CB_RO	Y	
5	TIE CB Y-PHASE OPEN	TIE_CB_Y_OPEN	T CB_YO	Y	
6	TIE CB B-PHASE OPEN	TIE_CB_B_OPEN	T CB_BO	Y	
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y	MAIN-1

B	Configuration of Digital Channels for 32 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y	
9	MAIN 2 ZONE-1 OPTD.	MAIN2_Z1_OPTD	M2Z1_OP	Y	
10	MAIN 2 ZONE-2 START	MAIN2_Z2_START	M2Z2_ST	N	
11	MAIN 2 ZONE-2 OPTD.	MAIN2_Z2_OPTD	M2Z2_OP	Y	
12	MAIN 2 ZONE-3 START	MAIN2_Z3_START	M2Z3_ST	N	
13	MAIN 2 ZONE-3 OPTD.	MAIN2_Z3_OPTD	M2Z3_OP	Y	
14	MAIN 2 REVERSE ZONE START	MAIN2_ZR_START	M2ZR_ST	N	
15	MAIN 2 REVERSE ZONE OPTD	MAIN2_ZR_OPTD	M2ZR_OP	Y	
16	POWER SWING DET.	PS_DETECTED	PS_DET	N	
17	POWER SWING BLOCK OPERATED	PS_BLK_OPTD	PSB_OP	N	
18	OVER VOLTAGE STAGE-1 OPERATED	O/V_STG1_OPTD	O/V_ST1	Y	
19	OVER VOLTAGE STAGE-2 OPERATED	O/V_STG2_OPTD	O/V_ST2	Y	
20	MAIN/TIE CB POLE DISCREPANCY	M/T_CB_POLE_DISC	M/T_PLDSC	N	
21	CARRIER AIDED TRIP	CAR_AID_TRP	CAR_TRP	Y	
22	MAIN-1 VT FUSE FAIL	VT_FUS_FAIL_M1	VT_FF_M1	N	MAIN-1
23	MAIN-2 VT FUSE FAIL	VT_FUS_FAIL_M2	VT_FF_M2	N	
24	MAIN-2 CARRIER RECEIVE	MAIN2_CARR_REC	M2_CR_RC	N	
25	OPTIONAL				
26	OPTIONAL				
27	OPTIONAL				
28	OPTIONAL				
29	OPTIONAL				
30	OPTIONAL				
31	OPTIONAL				
32	OPTIONAL				

	MAIN-1/2			
Configuration of Digital Channels for 16 channels				
S.No.	DIGITAL CHANNELS	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M_CB_RO	Y
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M_CB_YO	Y
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M_CB_BO	Y
4	TIE CB R-PHASE OPEN	TIE_CB_R_OPEN	T_CB_RO	Y
5	TIE CB Y-PHASE OPEN	TIE_CB_Y_OPEN	T_CB_YO	Y
6	TIE CB B-PHASE OPEN	TIE_CB_B_OPEN	T_CB_BO	Y
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y

9	AUTO RECLOSE OPTD M/T CB	M/T_CB_A/R_OPTD	M/TCBAR	Y
10	MAIN1/2 CARRIER RECEIVE	MAIN1/2_CARR_REC	M1/2_CR	N
11	MAIN 1/2 DEF OPTD	DEF_OPD	DEF_OPD	Y
12	DT RECEIVE CHANNEL-1/2	DT_REC_CH-1/2	DTRC1/2	Y
13	OVER VOLTAGE STAGE-1/2 OPERATED	O/V_STG1/2_OPTD	OVST1/2	Y
14	STUB/TEED/SOTF OPERATED	ST_TEE_SOTF_OPTD	STF_OPD	Y
15	BUSBAR OPERATED (M1/M2)	BUSBAR_OPTD	BB_OPD	Y
16	MAIN/TIE CB LBB OPERATED	M/T_LBB_OPTD	M/T_LBB	Y

2. DR for Transmission Line (Double Bus cum Transfer)

Main 1

A	Configuration of ANALOG CHANNELS	
S.No.	Channel Description	Standardized Channel Name
1	R Phase Current	I-R PH.
2	Y Phase Current	I-Y PH.
3	B Phase Current	I-B PH.
4	Neutral Current	I-N PH
5	R Phase Voltage	V-R PH.
6	Y Phase Voltage	V-Y PH.
7	B Phase Voltage	V-B PH.
8	Open Delta Voltage	V-N-Open Delta

B	Configuration of Digital Channels for 32 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M CB_RO	Y	
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M CB_YO	Y	
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M CB_BO	Y	
4	TBC CB R-PHASE OPEN	TBC_CB_R_OPEN	T CB_RO	Y	
5	TBC CB Y-PHASE OPEN	TBC_CB_Y_OPEN	T CB_YO	Y	
6	TBC CB B-PHASE OPEN	TBC_CB_B_OPEN	T CB_BO	Y	
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y	
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y	MAIN-2
9	AUTO RECLOSE OPTD MAIN CB	MAIN_CB_A/R_OPTD	M CB_AR	Y	
10	MAIN CB AR LOCKOUT	MAIN_CB_AR_LO	MCB_AR_LO	N	
11	AUTO RECLOSE OPTD TBC CB	TBC_CB_A/R_OPTD	T CB_AR	Y	
12	TBC CB AR LOCKOUT	TBC_CB_A/R_LO	AR_L/O	N	
13	MAIN1/2 CARRIER RECEIVE	MAIN1/2_CARR_REC	M1/2_CR	N	MAIN-1/2
14	DT RECEIVE CHANNEL-1/2	DT_REC_CH1/2	DTRC1/2	Y	

15	3 PH. GROUP A/B OPERATED	3PH_GR_A/B_OPTD	GRA/B_OPD	Y	
16	OVER VOLTAGE STAGE-1 OPERATED	O/V_STG1_OPTD	O/V_ST1	Y	
17	OVER VOLTAGE STAGE-2 OPERATED	O/V_STG2_OPTD	O/V_ST2	Y	
18	POWER SWING BLOCK OPERATED	PS_BLK_OPTD	PSB_OP	N	
19	MAIN-1 VT FUSE FAIL	VT_FUS_FAIL_M1	VT_FF_M1	N	
20	BUSBAR OPERATED (M1/M2)	BUSBAR_OPTD	BB_OPD	Y	
21	MAIN/TBC LBB OPERATED	M/T_LBB_OPTD	M/T_LBB	Y	
22	MAIN 1 ZONE-1 OPTD.	MAIN1_Z1_OPTD	M1Z1_OP	Y	
23	MAIN 1 ZONE-2 START	MAIN1_Z2_START	M1Z2_ST	N	
24	MAIN 1 ZONE-2 OPTD.	MAIN1_Z2_OPTD	M1Z2_OP	Y	
25	MAIN 1 ZONE-3 START	MAIN1_Z3_START	M1Z3_ST	N	
26	MAIN 1 ZONE-3 OPTD.	MAIN1_Z3_OPTD	M1Z3_OP	Y	
27	MAIN 1 REVERSE ZONE OPTD	MAIN1_ZR_OPTD	M1ZR_OP	Y	
28	MAIN 1/2 SOTF OPTD	M1/2_SOTF_OPD	M12SOTF	Y	
29	MAIN 1/2 DEF OPTD	DEF_OPD	DEF_OPD	Y	MAIN-1/2
30	MAIN1/2 CARR. SEND	M1/2_CARR. SEND	M12CRSD	N	MAIN-1/2
31	DIRECT TRIP SEND	DIR_TR SEND	DT_SEND	Y	
32	CARRIER AIDED TRIP	CARR_AID_TRIP	CAR_AID	Y	

	MAIN-2	
A	Configuration of ANALOG CHANNELS	
S.No.	Channel Description	Standardized Channel Name
1	R Phase Current	I-R PH.
2	Y Phase Current	I-Y PH.
3	B Phase Current	I-B PH.
4	Neutral Current	I-N PH.
5	R Phase Voltage	V-R PH.
6	Y Phase Voltage	V-Y PH.
7	B Phase Voltage	V-B PH.
8	Open Delta Voltage	V-N (Open Delta)

B	Configuration of Digital Channels for 32 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M_CB_RO	Y	
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M_CB_YO	Y	
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M_CB_BO	Y	
4	TBC CB R-PHASE OPEN	TBC_CB_R_OPEN	T_CB_RO	Y	
5	TBC CB Y-PHASE OPEN	TBC_CB_Y_OPEN	T_CB_YO	Y	
6	TBC CB B-PHASE OPEN	TIE_CB_B_OPEN	T_CB_BO	Y	
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y	MAIN-1
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y	

Construction of 1 (one) no. of 132/33kV, 50MVA Transformer Bay (both LV & HV) along with related services at 132kV Baghja GSS of AEGCL.

B Configuration of Digital Channels for 32 channels					
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
9	MAIN 2 ZONE-1 OPTD.	MAIN2_Z1_OPTD	M2Z1_OP	Y	
10	MAIN 2 ZONE-2 START	MAIN2_Z2_START	M2Z2_ST	N	
11	MAIN 2 ZONE-2 OPTD.	MAIN2_Z2_OPTD	M2Z2_OP	Y	
12	MAIN 2 ZONE-3 START	MAIN2_Z3_START	M2Z3_ST	N	
13	MAIN 2 ZONE-3 OPTD.	MAIN2_Z3_OPTD	M2Z3_OP	Y	
14	MAIN 2 REVERSE ZONE START	MAIN2_ZR_START	M2ZR_ST	N	
15	MAIN 2 REVERSE ZONE OPTD	MAIN2_ZR_OPTD	M2ZR_OP	Y	
16	POWER SWING DET.	PS_DETECTED	PS_DET	N	
17	POWER SWING BLOCK OPERATED	PS BLK OPTD	PSB_OP	N	
18	OVER VOLTAGE STAGE-1 OPERATED	O/V_STG1_OPTD	O/V_ST1	Y	
19	OVER VOLTAGE STAGE-2 OPERATED	O/V_STG2_OPTD	O/V_ST2	Y	
20	MAIN/TBC CB POLE DISCREPANCY	M/T_CB_POLE_DISC	M/T_PLDSC	N	
21	CARRIER AIDED TRIP	CAR_AID_TRP	CAR_TRP	Y	
22	DIRECT TRIP SEND	DIR_TR_SEND	DT_SEND	Y	
23	MAIN-2 VT FUSE FAIL	VT_FUS_FAIL_M2	VT_FF_M2	N	
24	MAIN-2 CARRIER RECEIVE	MAIN2_CARR_REC	M2_CR_RC	N	
25	OPTIONAL				
26	OPTIONAL				
27	OPTIONAL				
28	OPTIONAL				
29	OPTIONAL				
30	OPTIONAL				
31	OPTIONAL				
32	OPTIONAL				

Configuration of Digital Channels for 16 channels				
S.No.	DIGITAL CHANNELS	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB R-PHASE OPEN	MAIN_CB_R_OPEN	M CB_RO	Y
2	MAIN CB Y-PHASE OPEN	MAIN_CB_Y_OPEN	M CB_YO	Y
3	MAIN CB B-PHASE OPEN	MAIN_CB_B_OPEN	M CB_BO	Y
4	TBC CB R-PHASE OPEN	TBC_CB_R_OPEN	T CB_RO	Y
5	TBC CB Y-PHASE OPEN	TBC_CB_Y_OPEN	T CB_YO	Y
6	TBC CB B-PHASE OPEN	TBC_CB_B_OPEN	T CB_BO	Y
7	MAIN1 TRIP	MAIN1_TRIP	M1_TRIP	Y
8	MAIN2 TRIP	MAIN2_TRIP	M2_TRIP	Y
9	AUTO RECLOSE OPTD M/T CB	M/T_CB_A/R_OPTD	M/TCBAR	Y
10	MAIN1/2 CARRIER RECEIVE	MAIN1/2_CARR_REC	M1/2_CR	N

11	MAIN 1/2 DEF OPTD	DEF_OPD	DEF_OPD	Y
12	DT RECEIVE CHANNEL-1/2	DT_REC_CH-1/2	DTRC1/2	Y
13	OVER VOLTAGE STAGE-1/2 OPERATED	O/V_STG1/2_OPTD	OVST1/2	Y
14	SOTF OPERATED	SOTF_OPTD	STF_OPD	Y
15	BUSBAR OPERATED (M1/M2)	BUSBAR_OPTD	BB_OPD	Y
16	MAIN/TBC CB LBB OPERATED	M/T_LBB_OPTD	M/T_LBB	Y

3. DR for Transformer (one and half breaker scheme)

A	Configuration of ANALOG CHANNELS		
S.No.	Channel Description	Standardized Channel Name	COMMENTS
1	HV R Phase Current	I-R PH. HV	
2	HV Y Phase Current	I-Y PH. HV	
3	HV B Phase Current	I-B PH. HV	
4	HV Neutral Current	I-N HV	
5	IV R Phase Current	I-R PH. IV	
6	IV Y Phase Current	I-Y PH. IV	
7	IV B Phase Current	I-B PH. IV	
9	IV Neutral Current	I-N IV	
10	R Phase DIFFERENTIAL Current (CALCULATED)	IR DIFF	
11	Y Phase DIFFERENTIAL Current (CALCULATED)	IY DIFF	
12	B Phase DIFFERENTIAL Current (CALCULATED)	IB DIFF	
13	LV R Phase Current	L-R PH. IV	OPTIONAL
14	LV Y Phase Current	L-Y PH. IV	OPTIONAL
15	LV B Phase Current	L-B PH. IV	OPTIONAL
16	LV Neutral Current	L-N IV	OPTIONAL
17	HV R Ph Voltage	V-R PH HV	OPTIONAL
18	HV Y Ph Voltage	V-Y PH HV	OPTIONAL
19	HV B Ph Voltage	V-B PH HV	OPTIONAL

B	Configuration of Digital Channels for 32 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers	COMMENTS
1	MAIN CB OPEN (HV SIDE)	HV_M_CB_OPEN	HV_MCBO	Y	
2	TIE CB OPEN (HV SIDE)	HV_T_CB_OPEN	HV_TCBO	Y	
3	MAIN CB OPEN (IV SIDE)	IV_M_CB_OPEN	IV_MCBO	Y	
4	TIE/TBC CB OPEN (IV SIDE)	IV_T_CB_OPEN	IV_TCBO	Y	
5	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y	
6	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y	
7	HV OC PROTECTION OPERATED	HV_B/U_PROTN_OPD	HVBUOPD	Y	
8	HV EF PROTN OPERATED	HV_EF_PROTN_OPD	HVEFOPD	Y	
9	HV OVER FLUXING OPERATED	HV_OVERFLUX_OPTD	HVOFOPD	Y	

Construction of 1 (one) no. of 132/33kV, 50MVA Transformer Bay (both LV & HV) along with related services at 132kV Baghja GSS of AEGCL.

10	IV OVER FLUXING OPERATED	IV_OVERFLUX_OPTD	IVOFOPD	Y	
11	PRV TRIP	PRV_TRIP	PRV_TRP	Y	
12	WTI TRIP	WTI_TRIP	WTI_TR	Y	HV/IV/LV
13	OSR TRIP	OSR_TRIP	OSR_TRP	Y	
14	OTI TRIP	OTI_TRIP	OTI_TRP	Y	
15	BUCHHOLZ TRIP	BUCHHOLZ_TRIP	BCZ_TRP	Y	
16	3 PH. GROUP A OPERATED	3PH_GR_A_OPTD	GRA_OPD	Y	
17	3 PH. GROUP B OPERATED	3PH_GR_B_OPTD	GRB_OPD	Y	
18	MAIN CB (HV SIDE) LBB OPTD.	HV_MAIN_LBB_OPTD	H_M_LBB	Y	
19	MAIN CB (IV SIDE) LBB OPTD.	IV_MAIN_LBB_OPTD	I_M_LBB	Y	
20	TIE CB (HV SIDE) LBB OPTD.	HV_TIE_LBB_OPTD	H_T_LBB	Y	
21	TIE/TBC CB (IV SIDE) LBB OPTD.	IV_T_LBB_OPTD	I_T_LBB	Y	
22	BUSBAR OPERATED	BUSBAR_OPTD	BB_OPD	Y	
23	DTOC OPTD	DTOC_OPTD	DTOCOPD	Y	IF APPLICABLE
24	OLTC OIL SURGE TRIP	OLTC_OIL_SGTR	OL_SR_TR	Y	
25	HV VT FUSE FAIL ALARM	HVVT_FUS_FAIL	HVVT_FF	N	
26	WTI ALARM	WTI_ALARM	WTI_AL	N	HV/IV/LV
27	OTI ALARM	OTI_ALARM	OTI_AL	N	
28	OVER LOAD ALARM	OL_ALARM	OL_AL	N	
29					OPTIONAL
30					OPTIONAL
31					OPTIONAL
32					OPTIONAL

Configuration of Digital Channels for 16 channels

S.No.	DIGITAL CHANNELS	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB OPEN (HV SIDE)	HV_M_CB_OPEN	HV_MCBO	Y
2	TIE CB OPEN (HV SIDE)	HV_T_CB_OPEN	HV_TCBO	Y
3	MAIN CB OPEN (IV SIDE)	IV_M_CB_OPEN	IV_MCBO	Y
4	TBC/TIE CB OPEN (IV SIDE)	IV_T_CB_OPEN	IV_TCBO	Y
5	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y
6	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y
7	HV BACKUP PROTECTION OPERATED	HV_B/U_PROTN_OPD	HVBUOPD	Y
8	HV/IV OVER FLUXING OPERATED	HV/IV_O/F_OPD	O/F_OPD	Y
9	PRV TRIP	PRV_TRIP	PRV_TRP	Y
10	OTI/WTI TRIP	OTI/WTI_TRIP	OT/WT_T	Y
11	BUCHHOLZ/OSR TRIP	BUCH/OSR_TRIP	B_OSR_T	Y
12	MAIN/TIE CB (HV SIDE) LBB OPTD.	M/T_HV_LBB	HV_LBB	Y
13	MAIN/TBC CB (IV SIDE) LBB OPTD.	M/T_IV_LBB	IV_LBB	Y

14	BUSBAR OPERATED	BUSBAR_OPTD	BB_OPD	Y
15	DTOC OPTD	DTOC_OPTD	DTOCOPD	Y
16	3 PH. GROUP A/B OPERATED	3PH_GR_A/B_OPTD	GRA/B_OPD	Y

4. DR for Bus/Line Reactor for one and half breaker scheme

a. For back up Impedance Relay

A	Configuration of ANALOG CHANNELS		
S.No.	Channel Description	Standardized Channel Name	COMMENTS
1	R Phase Current	I-R PH.	
2	Y Phase Current	I-Y PH.	
3	B Phase Current	I-B PH.	
4	Neutral Current	I-N PH.	
5	R Phase Voltage	V-R PH.	
6	Y Phase Voltage	V-Y PH.	
7	B Phase Voltage	V-B PH.	
8	Neutral voltage	V-N PH.	

B	Configuration of Digital Channels for 32 channels			
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB OPEN	MAIN_CB_OPEN	M_CB_O	Y
2	TIE CB OPEN	TIE_CB_OPEN	T_CB_O	Y
3	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y
4	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y
5	BACKUP IMPEDANCE PROTN OPERATED	BU_IMP_PROTN_OPD	BUIMPOP	Y
6	PRV TRIP	PRV_TRIP	PRV_TRP	Y
7	WTI TRIP	WTI_TRIP	WTI_TRP	Y
8	WTI ALARM	WTI_ALARM	WTI_AL	Y
9	OTI TRIP	OTI_TRIP	OTI_TRP	Y
10	OTI ALARM	OTI_ALARM	OTI_AL	Y
11	BUCHHHOLZ TRIP	BUCHHHOLZ_TRIP	BCZ_TRP	Y
12	BUCHHHOLZ ALARM	BUCHHHOLZ_ALARM	BCZ_AL	Y
13	MAIN LBB OPERATED	MAIN_LBB_OPD	MLBBOPD	Y
14	TIE LBB OPERATED	TIE_LBB_OPD	TLBBOPD	Y
15	BUS BAR OPERATED	BUSBAR_OPTD	BB_OPD	Y
16	3 PH. GROUP A OPERATED	3PH_GR_A_OPTD	GRA_OPD	Y
17	3 PH. GROUP B OPERATED	3PH_GR_B_OPTD	GRB_OPD	Y
18	NGR PROTECTION OPERATED	NGR_PROTN_OPTD	NGR_OPD	Y
19	TEED PROTECTION OPERATED	TEED_PROTN_OPTD	TEE_OPD	Y
20	VT FUSE FAIL ALARM	VT_FUS_FAIL	VT_FF	N

B	Configuration of Digital Channels for 16 channels			
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB OPEN	MAIN_CB_OPEN	M_CB_O	Y
2	TIE CB OPEN	TIE_CB_OPEN	T_CB_O	Y
3	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y
4	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y
5	BACKUP IMPEDANCE PROTN OPERATED	BU_IMP_PROTN_OPD	BUIMPOP	Y
6	PRV TRIP	PRV_TRIP	PRV_TRP	Y
7	WTI TRIP	WTI_TRIP	WTI_TRP	Y
8	TEED PROTECTION OPERATED	TEED_PROTN_OPTD	TEE_OPD	Y
9	OTI TRIP	OTI_TRIP	OTI_TRP	Y
10	BUCHHHOLZ TRIP	BUCHHHOLZ_TRIP	BCZ_TRP	Y
11	MAIN LBB OPERATED	MAIN_LBB_OPD	MLBBOPD	Y
12	TIE LBB OPERATED	TIE_LBB_OPD	TLBBOPD	Y
13	BUS BAR OPERATED	BUSBAR_OPTD	BB_OPD	Y
14	3 PH. GROUP A OPERATED	3PH_GR_A_OPTD	GRA_OPD	Y
15	3 PH. GROUP B OPERATED	3PH_GR_B_OPTD	GRB_OPD	Y
16	NGR PROTECTION OPERATED	NGR_PROTN_OPTD	NGR_OPD	Y

b. For Main Differential Relay

A	Configuration of ANALOG CHANNELS	
S.No.	Channel Description	Standardized Channel Name
1	R Phase Current	I-R PH.
2	Y Phase Current	I-Y PH.
3	B Phase Current	I-B PH.
4	Neutral Current	I-N PH.
5	R Phase Current NEUTRAL SIDE	I-RN PH.
6	Y Phase Current NEUTRAL SIDE	I-YN PH.
7	B Phase Current NEUTRAL SIDE	I-BN PH.
8	R Phase DIFFERENTIAL Current (CALCULATED)	IR DIFF
9	Y Phase DIFFERENTIAL Current (CALCULATED)	IY DIFF
10	B Phase DIFFERENTIAL Current (CALCULATED)	IB DIFF

B	Configuration of Digital Channels for 32 channels			
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB OPEN	MAIN_CB_OPEN	M_CB_O	Y
2	TIE CB OPEN	TIE_CB_OPEN	T_CB_O	Y

3	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y
4	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y
5	BACKUP IMPEDANCE PROTN OPERATED	BU_IMP_PROTN_OPTD	BUIMPOP	Y
6	PRV TRIP	PRV_TRIP	PRV_TRP	Y
7	WTI TRIP	WTI_TRIP	WTI_TRP	Y
8	WTI ALARM	WTI_ALARM	WTI_AL	Y
9	OTI TRIP	OTI_TRIP	OTI_TRP	Y
10	OTI ALARM	OTI_ALARM	OTI_AL	Y
11	BUCHHHOLZ TRIP	BUCHHHOLZ_TRIP	BCZ_TRP	Y
12	BUCHHHOLZ ALARM	BUCHHHOLZ_ALARM	BCZ_AL	Y
13	MAIN LBB OPERATED	MAIN_LBB_OPD	MLBBOPD	Y
14	TIE LBB OPERATED	TIE_LBB_OPD	TLBBOPD	Y
15	BUS BAR OPERATED	BUSBAR_OPTD	BB_OPD	Y
16	3 PH. GROUP A OPERATED	3PH_GR_A_OPTD	GRA_OPD	Y
17	3 PH. GROUP B OPERATED	3PH_GR_B_OPTD	GRB_OPD	Y
18	NGR PROTECTION OPERATED	NGR_PROTN_OPTD	NGR_OPD	Y
19	TEED PROTECTION OPERATED	TEED_PROTN_OPTD	TEE_OPD	Y

B Configuration of Digital Channels for 16 channels				
S.No.	Channel Description	(Limited to 16 Characters)	7 characters	Triggers
1	MAIN CB OPEN	MAIN_CB_OPEN	M_CB_O	Y
2	TIE CB OPEN	TIE_CB_OPEN	T_CB_O	Y
3	DIFFERENTIAL PROTECTION OPERATED	DIFF_PROTN_OPTD	DIF_OPD	Y
4	REF PROTECTION OPERATED	REF_PROTN_OPTD	REF_OPD	Y
5	BACKUP IMPEDANCE PROTN OPERATED	BU_IMP_PROTN_OPTD	BUIMPOP	Y
6	PRV TRIP	PRV_TRIP	PRV_TRP	Y
7	WTI TRIP	WTI_TRIP	WTI_TRP	Y
8	TEED PROTECTION OPERATED	TEED_PROTN_OPTD	TEE_OPD	Y
9	OTI TRIP	OTI_TRIP	OTI_TRP	Y
10	BUCHHHOLZ TRIP	BUCHHHOLZ_TRIP	BCZ_TRP	Y
11	MAIN LBB OPERATED	MAIN_LBB_OPD	MLBBOPD	Y
12	TIE LBB OPERATED	TIE_LBB_OPD	TLBBOPD	Y
13	BUS BAR OPERATED	BUSBAR_OPTD	BB_OPD	Y
14	3 PH. GROUP A OPERATED	3PH_GR_A_OPTD	GRA_OPD	Y
15	3 PH. GROUP B OPERATED	3PH_GR_B_OPTD	GRB_OPD	Y
16	NGR PROTECTION OPERATED	NGR_PROTN_OPTD	NGR_OPD	Y

5. Standard list of Sequence of Events (SOE)

SCADA SIGNAL LIST FOR VARIOUS PROTECTION & CONTROL SIGNALS

REQUIRED SIGNALS FOR DISTANCE RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	OVERVOLTAGE STAGE 1 START	
2	SPI	OVERVOLTAGE STAGE 1 GEN TRIP	Y
3	SPI	OVERVOLTAGE STAGE 2 GEN TRIP	Y
4	SPI	DEF START	
5	SPI	DEF GEN TRIP	Y
6	SPI	STUB PROTECTION OPERATED	Y
7	SPI	SOTF OPERATED	Y
8	SPI	START, Z1 R PH	
9	SPI	START, Z1 Y PH	
10	SPI	START, Z1 B PH	
11	SPI	START, Z2	
12	SPI	START, Z3	
13	SPI	START, Z4	
14	SPI	START, Z5	
15	SPI	TRIP, Z1 R PH	Y
16	SPI	TRIP, Z1 Y PH	Y
17	SPI	TRIP, Z1 B PH	Y
18	SPI	GENERAL TRIP, Z2	Y
19	SPI	GENERAL TRIP, Z3	Y
20	SPI	GENERAL TRIP, Z4	Y
21	SPI	GENERAL TRIP, Z5	Y
22	SPI	CARRIER SEND	Y
23	SPI	CARRIER RECEIVE	Y
24	SPI	CARRIER AIDED SCHEME OPERATED	Y
25	SPI	POWER SWING DETECTED	Y
26	SPI	POWER SWING BLOCKING	Y
27	SPI	DISTANCE RELAY GENERAL TRIP	Y
28	DINT	FAULT LOCATOR DISTANCE	
29	SPI	CVT FUSE FAIL	Y
30	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
31	System Diagnosis (SON)	M1 IED UNHEALTHY	Y
32	SPI	START AR	
33	SPI	LINE ISOLATOR OPEN FOR STUB ACTIVATION	
34	SPI	DT SEND CH 1	Y

35	SPI	DT SEND CH 1	Y
36	SPI	DT RECEIVE CH 1	Y
37	SPI	DT RECEIVE CH 2	Y
38	SPI	MAIN CB R PH OPEN	
39	SPI	MAIN CB Y PH OPEN	
40	SPI	MAIN CB B PH OPEN	
41	SPI	TIE CB R PH OPEN	
42	SPI	TIE CB Y PH OPEN	
43	SPI	TIE CB B PH OPEN	
44	SPI	TRIP RELAY 86 A HEALTHY (SUPERVISION)	
45	SPI	TRIP RELAY 86 B HEALTHY (SUPERVISION)	
46	SPI	GR A RELAY OPERATED	Y
47	SPI	GR B RELAY OPERATED	Y
48	SPI	CARRIER CHANNEL 1/2 OUT OF SERVICE	Y
49	SPI	CARRIER CHANNEL 1 FAIL	Y
50	SPI	CARRIER CHANNEL 2 FAIL	Y
51	SPI	MAIN 2/1 RELAY FAIL	Y
52	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
53		ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR ICT DIFFERENTIAL RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	OVEREXCITATION HV START	
2	SPI	OVEREXCITATION HV ALARM	Y
3	SPI	OVEREXCITATION HV TRIP	Y
4	SPI	DIFFERENTIAL CURRENT ALARM	Y
5	SPI	DIFFERENTIAL PROTECTION TRIP	Y
6	INT	RESTRAINED MODE (RESTRAINED OR UNRESTRAINED)	
7	SPI	GENERAL TRIP	Y
8	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
9	System Diagnosis (SON)	DIFFERENTIAL IED UNHEALTHY	Y
10	SPI	DIFFERENTIAL RELAY GENERAL TRIP	Y

REQUIRED SIGNALS FOR ICT DIFFERENTIAL RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
11	SPI	OTI ALARM	Y
12	SPI	WTI HV ALARM	Y
13	SPI	WTI IV ALARM	Y
14	SPI	WTI MV ALARM	Y
15	SPI	BUCCHOLZ TRIP	Y
16	SPI	OSR 1 TRIP	Y
17	SPI	PRD 1 TRIP	Y
18	SPI	FIRE PROTECTION OPERATED	Y
19	SPI	LOW OIL LEVEL	Y
20	SPI	OTI R PH ALARM	Y
21	SPI	OTI Y PH ALARM	Y
22	SPI	OTI B PH ALARM	Y
23	SPI	OTI SPARE ICT ALARM	Y
24	SPI	WTI HV R PH ALARM	Y
25	SPI	WTI HV Y PH ALARM	Y
26	SPI	WTI HV B PH ALARM	Y
27	SPI	WTI HV SPARE ICT ALARM	Y
28	SPI	WTI MV R PH ALARM	Y
29	SPI	WTI MV Y PH ALARM	Y
30	SPI	WTI MV B PH ALARM	Y
31	SPI	WTI MV SPARE ICT ALARM	Y
32	SPI	WTI IV R PH ALARM	Y
33	SPI	WTI IV Y PH ALARM	Y
34	SPI	WTI IV B PH ALARM	Y
35	SPI	WTI IV SPARE ICT ALARM	Y
36	SPI	BUCCHOLZ R PH TRIP	Y
37	SPI	BUCCHOLZ Y PH TRIP	Y
38	SPI	BUCCHOLZ B PH TRIP	Y
39	SPI	BUCCHOLZ SPARE ICT TRIP	Y
40	SPI	OSR 1 R PH TRIP	Y
41	SPI	OSR 1 Y PH TRIP	Y
42	SPI	OSR 1 B PH TRIP	Y
43	SPI	OSR 1 SPARE ICT TRIP	Y
44	SPI	PRD 1 R PH TRIP	Y
45	SPI	PRD 1 Y PH TRIP	Y
46	SPI	PRD 1 B PH TRIP	Y
47	SPI	LOW OIL LEVEL R PH	Y
48	SPI	LOW OIL LEVEL Y PH	Y
49	SPI	LOW OIL LEVEL B PH	Y
50	SPI	LOW OIL LEVEL SPARE ICT	Y
51	SPI	FIRE PROTECTION R PH OPERATED	Y

REQUIRED SIGNALS FOR ICT DIFFERENTIAL RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
52	SPI	FIRE PROTECTION Y PH OPERATED	Y
53	SPI	FIRE PROTECTION B PH OPERATED	Y
54	SPI	FIRE PROTECTION SPARE ICT OPERATED	Y
55	SPI	MAIN CB R PH OPEN	
56	SPI	MAIN CB Y PH OPEN	
57	SPI	MAIN CB B PH OPEN	
58	SPI	TIE CB R PH OPEN	
59	SPI	TIE CB Y PH OPEN	
60	SPI	TIE CB B PH OPEN	
61	SPI	TRIP RELAY 86 A HEALTHY (SUPERVISION)	Y
62	SPI	TRIP RELAY 86 B HEALTHY (SUPERVISION)	Y
63	SPI	GR A RELAY OPERATED	Y
64	SPI	GR B RELAY OPERATED	Y
65	SPI	REF RELAY FAIL	Y
66	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
67	SPI	ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR ICT REF RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	OVEREXCITATION MV START	
2	SPI	OVEREXCITATION MV ALARM	Y
3	SPI	OVEREXCITATION MV TRIP	Y
4	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
5	System Diagnosis (SON)	DIFFERENTIAL IED UNHEALTHY	Y
6	SPI	REF RELAY ALARM	Y
7	SPI	REF TRIP	Y
8	SPI	GENERAL TRIP	Y
9	SPI	REF TRIP	Y
10	SPI	OTI TRIP	Y
11	SPI	WTI HV TRIP	Y

REQUIRED SIGNALS FOR ICT REF RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
12	SPI	WTI MV TRIP	Y
13	SPI	WTI LV TRIP	Y
14	SPI	OSR 2 TRIP	Y
15	SPI	PRD 2 TRIP	Y
16	SPI	BUCCHOLZ ALARM	Y
17	SPI	OTI R PH TRIP	Y
18	SPI	OTI Y PH TRIP	Y
19	SPI	OTI B PH TRIP	Y
20	SPI	OTI SPARE ICT TRIP	Y
21	SPI	WTI HV R PH TRIP	Y
22	SPI	WTI HV Y PH TRIP	Y
23	SPI	WTI HV B PH TRIP	Y
24	SPI	WTI HV SPARE ICT TRIP	Y
25	SPI	WTI MV R PH TRIP	Y
26	SPI	WTI MV Y PH TRIP	Y
27	SPI	WTI MV B PH TRIP	Y
28	SPI	WTI MV SPARE ICT TRIP	Y
29	SPI	WTI IV R PH TRIP	Y
30	SPI	WTI IV Y PH TRIP	Y
31	SPI	WTI IV B PH TRIP	Y
32	SPI	WTI IV SPARE ICT TRIP	Y
33	SPI	BUCCHOLZ R PH ALARM	Y
34	SPI	BUCCHOLZ Y PH ALARM	Y
35	SPI	BUCCHOLZ B PH ALARM	Y
36	SPI	BUCCHOLZ SPARE ICT ALARM	Y
37	SPI	OSR 2 R PH TRIP	Y
38	SPI	OSR 2 Y PH TRIP	Y
39	SPI	OSR 2 B PH TRIP	Y
40	SPI	OSR 2 SPARE ICT TRIP	Y
41	SPI	PRD 2 R PH TRIP	Y
42	SPI	PRD 2 Y PH TRIP	Y
43	SPI	PRD 2 B PH TRIP	Y
44	SPI	PRD 2 SPARE ICT TRIP	Y
45	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
46		ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR DIRECTIONAL OVERCURRENT AND EARTH FAULT RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED

Construction of 1 (one) no. of 132/33kV, 50MVA Transformer Bay (both LV & HV) along with related services at 132kV Baghjap GSS of AEGCL.

1	SPI	DEF START	
2	SPI	DEF GEN TRIP	Y
3	SPI	DIRECTIONAL OVERCURRENT START	Y
4	SPI	DIRECTIONAL OVERCURRENT TRIP	Y
5	SPI	GENERAL TRIP	Y
6	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
7	System Diagnosis (SON)	M1 IED UNHEALTHY	Y
8	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
9		ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR REACTOR DIFFERENTIAL RELAYS			
SL.NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	DIFFERENTIAL PROTECTION TRIP	Y
2	SPI	DIFFERENTIAL CURRENT ALARM	Y
3	SPI	TEE DIFFERENTIAL PROTECTION TRIP	Y
4	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
5	System Diagnosis (SON)	DIFFERENTIAL IED UNHEALTHY	Y
6	SPI	DIFFERENTIAL RELAY GENERAL TRIP	Y
7	SPI	OTI ALARM	Y
8	SPI	WTI ALARM	Y
9	SPI	BUCCHOLZ TRIP	Y
10	SPI	OSR TRIP	Y
11	SPI	PRD TRIP	Y
12	SPI	FIRE PROTECTION OPERATED	Y
13	SPI	LOW OIL LEVEL	Y
14	SPI	OTI R PH ALARM	Y
15	SPI	OTI Y PH ALARM	Y
16	SPI	OTI B PH ALARM	Y

17	SPI	OTI SPARE PH ALARM	Y
18	SPI	WTI R PH ALARM	Y
19	SPI	WTI Y PH ALARM	Y
20	SPI	WTI B PH ALARM	Y
21	SPI	WTI SPARE ICT ALARM	Y
22	SPI	BUCCHOLZ R PH TRIP	Y
23	SPI	BUCCHOLZ Y PH TRIP	Y
24	SPI	BUCCHOLZ B PH TRIP	Y
25	SPI	BUCCHOLZ SPARE PH TRIP	Y
26	SPI	OSR R PH TRIP	Y
27	SPI	OSR Y PH TRIP	Y
28	SPI	OSR B PH TRIP	Y
29	SPI	OSR SPARE ICT TRIP	Y
30	SPI	PRD R PH TRIP	Y
31	SPI	PRD Y PH TRIP	Y
32	SPI	PRD B PH TRIP	Y
33	SPI	LOW OIL LEVEL R PH	Y
34	SPI	LOW OIL LEVEL Y PH	Y
35	SPI	LOW OIL LEVEL B PH	Y
36	SPI	LOW OIL LEVEL SPARE ICT	Y
37	SPI	FIRE PROTECTION R PH OPERATED	Y
38	SPI	FIRE PROTECTION Y PH OPERATED	Y
39	SPI	FIRE PROTECTION B PH OPERATED	Y
40	SPI	FIRE PROTECTION SPARE ICT OPERATED	Y
41	SPI	MAIN CB R PH OPEN	Y
42	SPI	MAIN CB Y PH OPEN	Y
43	SPI	MAIN CB B PH OPEN	Y
44	SPI	TIE CB R PH OPEN	Y
45	SPI	TIE CB Y PH OPEN	Y
46	SPI	TIE CB B PH OPEN	Y
47	SPI	TRIP RELAY 86 A HEALTHY (SUPERVISION)	Y
48	SPI	TRIP RELAY 86 B HEALTHY (SUPERVISION)	Y
49	SPI	GR A RELAY OPERATED	Y
50	SPI	GR B RELAY OPERATED	Y
51	SPI	REF RELAY FAIL	Y
52	SPI	REACTOR CB R PH OPEN	APPLICABLE FOR SWITCHABLE REACTOR APPLICATION

53	SPI	REACTOR CB Y PH OPEN	
54	SPI	REACTOR CB B PH OPEN	
55	SPI	REACTOR CB SPARE PH OPEN	
56	SPI	GR A RELAY OPERATED	Y
57	SPI	GR B RELAY OPERATED	Y
58	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
59	SPI	ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR REACTOR REF RELAYS			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
2	System Diagnosis (SON)	DIFFERENTIAL IED UNHEALTHY	Y
3	SPI	REF RELAY ALARM	Y
4	SPI	REF TRIP	Y
5	SPI	GENERAL TRIP	Y
6	SPI	REF TRIP	Y
7	SPI	OTI TRIP	Y
8	SPI	WTI TRIP	Y
9	SPI	BUCCHOLZ ALARM	Y
10	SPI	OTI R PH TRIP	Y
11	SPI	OTI Y PH TRIP	Y
12	SPI	OTI B PH TRIP	Y
13	SPI	OTI SPARE ICT TRIP	Y
14	SPI	WTI R PH TRIP	Y
15	SPI	WTI Y PH TRIP	Y
16	SPI	WTI B PH TRIP	Y
17	SPI	WTI SPARE PH TRIP	Y
18	SPI	BUCCHOLZ R PH ALARM	Y
19	SPI	BUCCHOLZ Y PH ALARM	Y
20	SPI	BUCCHOLZ B PH ALARM	Y
21	SPI	BUCCHOLZ SPARE PH ALARM	Y
22	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y

23		ANY ADDITIONAL SIGNAL AS PER SCHEME	
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REQUIRED SIGNALS FOR REACTOR BACKUP IMPEDANCE PROTECTION RELAY			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	START Z1	
2	SPI	Z1 TRIP	Y
3	SPI	GENERAL TRIP	Y
4	DINT	FAULT LOCATOR DISTANCE	
5	SPI	CVT FUSE FAIL	Y
6	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
7	System Diagnosis (SON)	M1 IED UNHEALTHY	Y
22	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
8		ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR BUS BAR PROTECTION RELAYS			
SL.NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	BUS ZONE 1 TRIP	Y
2	SPI	BUS ZONE 2 TRIP	Y
3	SPI	BUS BAR BLOCKED EXTERNAL	Y
4	SPI	BUS BAR BLOCKED DUE TO COMMUNICATIONN ERROR	Y
5	SPI	BUS BAR BLOCKED DUE TO INTERMEDIATE STATUS	Y
6		CT CIRCUIT ERROR	Y

REQUIRED SIGNALS FOR BREAKER FAILURE PROTECTION RELAY PROTECTION RELAY			
SL. NO.	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED
1	SPI	BREAKER FAILURE PROTECTION START	Y
2	SPI	BREAKER FAILURE TRIP	Y
3	SPI	BREAKER FAILURE RETRIP	Y

4	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y
5	System Diagnosis (SON)	M1 IED UNHEALTHY	Y
6	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y
7			
8		ANY ADDITIONAL SIGNAL AS PER SCHEME	

REQUIRED SIGNALS FOR BAY CONTROL UNIT				
SL.NO	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED	ADDITIONAL REMARKS
1	INT	BCU IN LOCAL/ REMOTE		
2	SPI	CLOSE COMMAND FROM BCU FOR AUTORECLOSE		
3	SPI	BLOCK AUTORECLOSE FUNCTION	Y	

4	INT	STATUS 1 AUTORECLOSE FUNCTION READY		
		STATUS 2 AUTORECLOSE IN PROGRESS	Y	
		STATUS 3 AUTORECLOSE SUCCESSFUL	Y	
		STATUS 10 AUTORECLOSE UNSUCCESSFUL	Y	Available in Edition 2 IEDs, not in Edition 1 IEDs
5	CMD	BAY_CB_COMMAND		
6	SPI	BAY_CB_OPEN PERMITTED OR ENABLED		
7	SPI	BAY_CB_CLOSE PERMITTED OR ENABLED		
8	DPI	BAY_CB R PH POSITION		
9	DPI	BAY_CB Y PH POSITION		
10	DPI	BAY_CB B PH POSITION		
11	DPI	BAY_89A_ISOLATOR POSITION		
12	CMD	BAY_89A_ISO COMMAND		
13	SPI	BAY_89A_ISO OPEN PERMITTED OR ENABLED		

REQUIRED SIGNALS FOR BAY CONTROL UNIT				
SL.NO	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED	ADDITIONAL REMARKS
14	SPI	BAY_89A_CLOSE PERMITTED OR ENABLED		
15	DPI	BAY_89AE_ISOLATOR POSITION		IF BUS EARTH SWITCH IS IN THE BAY FOR WHICH THE ASSIGNMENT IS BEING DONE, CSWI3 SHALL BE USED FOR 89 AE 1, i.e. BUS EARTH SWITCH. FOR BAY SIDE EARTH SWITCH (89AE2) SEPARATE LOGICAL NODE CSWI 10 IS PROVIDED BELOW
16	CMD	BAY_89AE_ISO COMMAND		
17	SPI	BAY_89AE_ISO OPEN PERMITTED OR ENABLED		
18	SPI	BAY_89AE_CLOSE PERMITTED OR ENABLED		
19	DPI	BAY_89 B_ISOLATOR POSITION		
20	CMD	BAY_89 B_ISO COMMAND		
21	SPI	BAY_89 B_ISO OPEN PERMITTED OR ENABLED		
22	SPI	BAY_89 B_CLOSE PERMITTED OR ENABLED		
23	DPI	BAY_89 BE_ISOLATOR POSITION		
24	CMD	BAY_89 BE_ISO COMMAND		
25	SPI	BAY_89 BE_ISO OPEN PERMITTED OR ENABLED		
26	SPI	BAY_89 BE_CLOSE PERMITTED OR ENABLED		
27	DPI	BAY_89 C/L/T_ISOLATOR POSITION		FOR 3 PHASE TRANSFORMER S CSWI7 MAY BE USED FOR 89 T BUT FOR SINGLE PHASE TRANSFORMER S SAME HAS BEEN SEPARATELY MENTIONED
28	CMD	BAY_89 C/L/T_ISO COMMAND		
29	SPI	BAY_89 C/L/T_ISO OPEN PERMITTED OR ENABLED		
30	SPI	BAY_89 C/L/T_CLOSE PERMITTED OR ENABLED		
31	DPI	BAY_89 CE/LE/TE_ISOLATOR POSITION		FOR 3 PHASE TRANSFORMER S CSWI7 MAY BE USED FOR
32	CMD	BAY_89 CE/LE/TE_ISO COMMAND		

REQUIRED SIGNALS FOR BAY CONTROL UNIT				
SL.NO	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED	ADDITIONAL REMARKS
33	SPI	BAY_89 CE/LE/TE_ISO OPEN PERMITTED OR ENABLED		89 TE BUT FOR SINGLE PHASE TRANSFORMER S SAME HAS BEEN SEPARATELY MENTIONED
34	SPI	BAY_89 CE/LE/TE_CLOSE PERMITTED OR ENABLED		
35	DPI	BAY_89 R_ISOLATOR POSITION		
36	CMD	BAY_89 R_ISO COMMAND		
37	SPI	BAY_89 R_ISO OPEN PERMITTED OR ENABLED		
38	SPI	BAY_89 R_CLOSE PERMITTED OR ENABLED		
39	DPI	BAY_89 RE_ISOLATOR POSITION		
40	CMD	BAY_89 RE_ISO COMMAND		
41	SPI	BAY_89 RE_ISO OPEN PERMITTED OR ENABLED		
42	SPI	BAY_89 RE_CLOSE PERMITTED OR ENABLED		
43	DPI	BAY_89AE 2_ISOLATOR POSITION		USED FOR SECOND EARTH SWITCH OF ISOLATOR, WHEN BUS EARTH SWITCH IS PROVIDED
44	CMD	BAY_89AE 2_ISO COMMAND		
45	SPI	BAY_89AE 2_ISO OPEN PERMITTED OR ENABLED		
46	SPI	BAY_89AE 2_CLOSE PERMITTED OR ENABLED		
THE LOGICAL NODES FOR ISOLATOR & EARTHSWITCHES FOR 3 PH ICTs & REACTORS , e.g 89 RR,RR1,RR2 & RE and for 89TR,TR1,TR2,TRE MAY BE ASSIGNED AS PER AVAILABILITY				
47	System Diagnosis (SON)	TIME SYNCHRONIZATION ERROR	Y	
48	System Diagnosis (SON)	BCU UNHEALTHY	Y	
49	SPI	CONDITIONS OK FOR SYNCHRONIZATION		
50	SPI	SPRING DISCHARGED	Y	ANNUNCIATION FOR CIRCUIT BREAKER
51	SPI	AC MOTOR SUPPLY FAIL	Y	
52	SPI	SF6 GAS LOW	Y	

REQUIRED SIGNALS FOR BAY CONTROL UNIT				
SL.NO	TYPE	EVENT/ALARM NAME	WHETHER ALARM TO BE GENERATED	ADDITIONAL REMARKS
53	SPI	OPERATION LOCKED OUT	Y	
54	SPI	CB READY FOR AUTORECLOSURE	Y	
55	SPI	DC SUPPLY FAIL	Y	
56	SPI	TC-1 FAIL	Y	
57	SPI	TC-2 FAIL	Y	
58	SPI	POLE DISCREPANCY RELAY OPTD	Y	
59	SPI	COMPRESSOR SUPPLY FAIL	Y	
60	SPI	AIR PRESSURE LOW	Y	
61	SPI	COMPRESSOR RUN TIME SUPERVISION	Y	
62	SPI	CSD FAIL	Y	
63	SPI	GAS COMPARTMENT n Alarm Stage n	Y	ANNUNCIATION FOR GIS BAYS
64	SPI	LCC PANEL AC SUPPLY FAIL	Y	
65	SPI	LCC PANEL DC SUPPLY FAIL	Y	
66	SPI	SELECTOR SWITCH POSITION LOCAL/REMOTE	Y	
67	SPI	BUS VT MCB TRIP	Y	FOR BCUs HAVING BUS VT INPUT
6	SPI	GOOSE RECEIPT FAIL/TROUBLE	Y	
68	SPI	ADDL SIGNALS FOR CB TROUBLE ETC AS PER SCHEME		

6. List of Signal for Station Auxiliaries Panel (SAS)

110V DC

1. Voltage of 110V DCDB-1
2. Voltage of 110V DCDB-2
3. Current from 110V Battery Set -1
4. Current from 110V Battery Set -2
5. Current from 110V Battery Charger -1
6. Current from 110V Battery charger 2
7. Battery 1 Output Voltage
8. Battery 2 Output Voltage
9. Charger Trouble 1
10. Charger Trouble 2
11. Charger 1 on Boost
12. Charger 1 on Float
13. Charger 1 Failure (Float)
14. Charger 1 Failure (FCBC)
15. Charger 2 on Boost
16. Charger 2 on Float
17. Charger 2 Failure (Float)
18. Charger 2 Failure (FCBC)

- 19.Charger 1 Float Current
- 20.Charger 1 Boost Current
- 21.Charger 2 Float Current
- 22.Charger 2 Boost Current
- 23.Input MCCB Incomer-1 ON (DCDB)
- 24.Input MCCB Incomer-2 ON (DCDB)
- 25.DCDB Bus coupler MCCB OFF
- 26.DC Earth Fault Relay Operated Sec-I
- 27.DC Earth Fault Relay Operated Sec-II
- 28.415 V AC Supply MCCB-1 Trip
29. 415 V AC Supply MCCB-2 Trip
- 30.Over Temperature Indication
- 31.DC Overvoltage and Undervoltage relay operated
- 32.AC Supply Trouble (Charger)

Separate Signal for both
Charger 1, Charger 2,
DCDB 1 and DCDB 2

48 V DC

1. Voltage of 48 V DCDB 1
2. Voltage of 48 V DCDB 2
3. Current from 48 V Battery set 1
4. Current from Battery Set 2
5. Current from 48 V Charger 1
6. Current from 48 V Charger 2
7. Battery 1 Output Voltage
8. Battery 2 Output Voltage
9. Charger Trouble 1
- 10.Charger Trouble 2
- 11.Charger 1 on Boost
- 12.Charger 1 on Float
- 13.Charger 1 Failure (Float)
- 14.Charger 1 Failure (FCBC)
- 15.Charger 2 on Boost
- 16.Charger 2 on Float
- 17.Charger 2 Failure (Float)
- 18.Charger 2 Failure (FCBC)
- 19.Charger 1 Float Current
- 20.Charger 1 Boost Current
- 21.Charger 2 Float Current
- 22.Charger 2 Boost Current
- 23.Input MCCB Incomer-1 ON (DCDB)
- 24.Input MCCB Incomer-2 ON (DCDB)
- 25.DCDB Bus coupler MCCB OFF
- 26.DC Earth Fault Relay Operated Sec-I
- 27.DC Earth Fault Relay Operated Sec-II
- 28.415 V AC Supply MCCB-1 Trip
29. 415 V AC Supply MCCB-2 Trip
- 30.Over Temperature Indication
- 31.DC Overvoltage and Undervoltage relay operated
- 32.AC Supply Trouble (Charger)

DG Set

1. DG Set Breaker ON
2. DG Set Breaker OFF
3. Low Lube Oil Pressure
4. High Water Temperature
5. Engine Over Speed

6. Low Fuel in Service Tank
7. Over load Trip
8. Voltage RY, YB and BR
9. Current from DG set R, Y and B

Fire Fighting

1. Zone 1 Fire
2. Zone 2 Fire
3. Zone 3 Fire
4. Zone 4 Fire
5. Zone 5 Fire

Other Signal

1. PLCC Exchange Fail
2. Time Synch. Signal Fail
3. GPS Signal Fail
4. Current from Station transformer
5. Voltage from Station Transformer
6. Isolator Status of Station Transformer
7. Ambient Temperature .

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, 2.5sq.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 2mm.

10.2.2 XLPE PowerCables

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 PowerCables

10.2.3.1 The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554(Part-1) 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 ControlCables

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 IS-7098 Part(1)	Extruded PVC type A as per IS-5831	Extruded PVC type A as per IS-5831
	b) Thickness of insulation(m m)	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		

SECTION-11

TECHNICAL SPECIFICATION OF COUPLING CAPACITOR WITH POTENTIAL DEVICE (CVT)

11.1.0 GENERAL

11.1.1 The coupling capacitors shall conform to the following electrical characteristics:-

A	Nominal system voltage	132KV
B	Maximum system voltage	145KV
C	Rated power frequency	50Hz
D	One minute power frequency withstand test	275KV voltage
E	Impulse withstand test voltage with standard full wave	650KV(1.2/50/us
F	Rated capacity	4400pF
G	Maximum loss factor at power frequency and rated voltage	0.5%

11.1.2 Coupling capacitors shall be suitable for use with PLC system having frequency range from 80 to 450 KHZ.

11.1.3 The coupling capacitors are required with suitable potential device. The potential device and coupling capacitor will form one unit and the coupling capacitor will be mounted on the top of the potential device. The primary of the potential device shall be connected to tap on the coupling capacitor corresponding to $20/\sqrt{3}$ kV. Two secondary windings shall be offered by the Bidder with output of $110/\sqrt{3}$ V. The output of each secondary winding shall be 100 VA. Accuracy class shall be 0.2 and 3P for Winding-I and Winding-II respectively.

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. 48V Battery Bank

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 signaling 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 to 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 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 heat shrinkable sleeves except at the connecting points.

12.2.7. ELECTROLYTE:

The electrolyte shall be prepared from the battery grade Sulphuric Acid conforming to IS: 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: 1069.

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 cast 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 its rated 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 centre 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 be 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 tropicalised 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 up to 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 and 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-hygroscopic, 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

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 busbar 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 switchboard 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. Busbar 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 Coupler 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 be deemed to be included in the scope of works.

SECTION-13 VACUUM CIRCUIT BREAKERS

SPECIFICATION OF 36 KV OUTDOOR TYPE PORCELAIN CLAD VACUUM CIRCUIT BREAKERS (PCVCB)

13.1.0 GENERAL TECHNICAL REQUIREMENTS

13.1.1 INTRODUCTION

The circuit breakers should be complete in all respects with insulators, bimetallic connectors, interrupting chamber, operating mechanism control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The scope of supply shall also include necessary special tools and plants required for erection as indicated, if any.

13.1.2 STANDARDS

The circuit breaker shall conform in all respects to the requirements of latest issue of IS/IEC specifications except for modifications specified herein. The equipment manufactured according to any other authoritative standards which ensure an equal or better quality than the provision of IS/IEC specifications shall also be acceptable. The salient point of difference between the proposed standard and provision of these specification shall be clearly brought out in the tender. A copy of English version of such specifications shall be enclosed with the tender.

The list of standards mentioned in this specification and to which the circuit conform is given below:

1.	IEC-62271-100	High Voltage A.C. Circuit Breakers
2.	IEC-60137	Bushing for alternating Voltages above 1000 volts
3.	IEC-60071	Insulation Co-ordination
4.	IEC-60694	Common clauses for high voltages switchgear and control gear standards
5.	IEC-60815	Specification for Creepage distances
6.	IS-13118	Specifications for high voltage alternating current circuit breakers
7.	IS-2099	High voltages porcelain bushings
8.	IS-4379	Identification of the contents of industrial gas cylinders
9.	IS-3072	Installation and maintenance of switchgear
10.	IEC-60267	Guide for testing of circuit breakers with respect to out of phase switching
11.	IS-802	Code of practice for use of structural steel in overhead transmission lines
12.	IEC-17A Study Group Dec.1981	Sealing of interrupters / breakers
13.	IS-1554	PVC insulated cables upto and including 1000 volts
14.	IS-5	Colors for ready mixed paints and channels

15.	Ref.Standard IES	Internal Electro-Technical Commission Bureau Central Data Commission, Electro Technique International, 1, RuedeVerembe, Geneva, Switzerland
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16.	IS	Indian Standard Bureau of India Standard, Manak Bhawan 9, Bahadurshah Zafar Marg, New Delhi – 110002, India
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13.1.3 SERVICE CONDITONS

CLIMATIC CONDITONS

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation as per section-I.

AUXILIARY POWER SUPPLY

Auxiliary electrical equipment shall be suitable for operation on the following supply system.

- | | | |
|---|---|--|
| 13.1.3.1 Power Devices (like motors) | : | 415 V, 3 phase 4 wire 50 hz, neutral grounded
AC supply |
| 13.1.3.2 DC Alarm, Control and
Protective
Devices | : | 220/110 V DC, ungrounded 2 wire (Substation wise exact
details shall be furnished by the successful bidder after
survey) |
| 13.1.3.3 Lighting | : | 240 V, single phase 50 Hz AC supply |

Bidder's scope includes supply of interconnecting cables, terminal boxes, etc. The above supply voltage may vary as indicated below and all devices shall be suitable for continuous operation over the entire range of voltages

- | | | |
|-----|-----------|---------------------------------------|
| i) | AC Supply | Voltage + 10% -15% Frequency $\pm$ 5% |
| ii) | DC Supply | -15% to + 10% |

13.1.4 GENERAL REQUIREMENT OF 36 KV/OUTDOOR VACUUM CIRCUIT BREAKERS

The vacuum type circuit breaker shall have vacuum interrupters, designed to provide a long contact life at all currents up to rated making and breaking current during switching operation. The vacuum interrupters sealed for life shall be encapsulated by porcelain insulators for outdoor installation requirement of the circuit breakers. The offered breakers shall be suitable for outdoor operation under climatic conditions specified without any protection from sun, rain and dust storm.

The vacuum interrupters of each phase shall be housed in a separate porcelain insulator. The three identical poles shall be mounted on a common base frame and the contact system of three poles should be mechanically linked to provide three pole gang opening/closing for all type of faults.

- i) The offered equipment shall be practically maintenance free over a long period.

- ii) All mechanical parts and linkages shall be robust in construction and maintenance free, over at least 10,000 switching operations, except for lubrication of pins/articulated joints at interval of 5 years or 5000 operations.
- iii) 2 separate DC source input shall be provided for 2 trip coils.
- iv) Similar parts shall be strictly interchangeable without special adjustment of individual fittings. Parts requiring maintenance shall be easily accessible, without requiring extensive dismantling of adjacent parts.
- v) The operating mechanism will be self-maintained and of proper operation endurance not less than the mechanical life of circuit breaking unit. It shall be spring operated type described hereinafter.
- vi) The circuit breaker shall be supplied complete with all auxiliary equipment, meant necessary for the safe operation, routine and periodic maintenance. All internal wiring including those of spare auxiliary contacts shall be complete and wired up to terminal blocks.
- vii) The breaker shall be totally re-strike free under all duty conditions. The details of any device incorporated to limit or control the rate of rise of re-striking voltage across the circuit breaker contacts shall be stated.
- viii) The breaker shall be reasonably quiet in operation and the noise level shall not exceed 140 decibels.
- ix) The breaker shall be suitable for three phase re-closing operation.
- x) An operation counter, visible from the ground level even with the mechanism housing closed shall be provided.
- xi) Suitable platform with ladder shall be provided for proper manual operation/maintenance of the breaker.
- xii) Breaker ON and OFF indication, spring charge indication shall be provided. Necessary provision for AC and DC supply healthy/fail status shall be provided.
- xiii) **Breaker shall be suitable for capacitor bank duty (as applicable).**

13.1.5 FIXED AND MOVING CONTACT

The fixed and moving contacts of the breaker have to ensure permanent full contact during closing. All making and breaking contacts shall be hermetically sealed and free from atmospheric effects.

The main contacts should have low contact resistance.

13.1.6 RECOVERY VOLTAGE AND POWER FACTOR

The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor equal to or exceeding 0.15. In case of multiple break circuit breaker, devices/method adopted for ensuring uniform voltage distribution across all the breaks shall be indicated and actual voltage distribution recorded during interruption tests shall be furnished with the bid.

13.1.7 RESTRIKING RECOVERY

The complete data for the phase factor, amplitude factor, etc., for rate of rise of re-striking voltage shall be furnished in the tender.

13.1.8 LINE CHARGING INTERRUPTING CAPACITY

The circuit breaker shall be designed so as to be capable of interrupting line charging currents without undue rise in the voltage on the supply side without re-strike and without showing sign of undue strains.

The maximum permissible switching over voltage shall not exceed 2.5 p.u. The guaranteed over voltage, which will not be exceeded while interrupting the rated line charging current for which the breaker is designed to interrupt shall also be stated. The results of the tests conducted along with the copies of the oscillographs to prove ability of the breakers to interrupt the rated as well as lower values of the line charging current shall be furnished with the tender.

13.1.9 TRANSFORMER CHARGING CURRENT BREAKING CAPACITY

The breaker shall be capable of interrupting inductive currents, such as those occurring while switching off unloaded transformers, without giving rise to undue over voltage and without re-strikes. The maximum over voltage value, which will not be exceeded under such conditions shall be stated in the tender.

13.1.10 BREAKING CAPACITY FOR SHORTLINE FAULTS

The interrupting capacity of the breaker for short line faults shall be stated in the tender. The details of the test conducted for proving the capability of the breaker under a short line fault occurring from one phase to earth conditions shall also be stated in the tender. The rated characteristics for short line faults shall be in accordance with stipulation contained in clause 4.105 of IEC 62271-100.

13.1.11 AUTOMATIC RAPID RECLOSING

36 kV circuit breaker shall be suitable for 3 pole rapid re-closing.

13.1.12 OUT OF PHASE SWITCHING

The circuit breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronization. The maximum power that the breaker can satisfactorily interrupt under "Phase Opposition" shall be stated in the bid".

13.1.13 TEMPERATURE RISE

The maximum temperature attained by any part of the equipment when in service at side and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperature specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the bid.

13.1.14 INSULATORS SUPPORTS AND HOUSING

The porcelain used shall be homogenous, free from cavities and other flaws. The insulators shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. The puncture strength of bushing shall be greater than the flash over value. The design of bushing shall be such that the complete bushing in a self-contained unit and no audible discharge shall be detected at a voltage up to a working voltage (Phase Voltage) plus 10%. The support insulator shall conform to IEC-60137. Minimum clearance between phases, between live parts and

grounded objects shall be as per IS-3072-1975 and should conform to Indian Electricity Rules-1956. The minimum creepage distance for severely polluted atmosphere shall be 31 mm/KV as per IEC-815-1985.

The details for atmospheric pollution of various sub-stations where these breakers are to be installed shall be as per Clause 1.3.1 of this specification. The air clearance of bushing should be such that if the bushings were tested at an altitude of less than 1000 meters, air clearance would withstand the application of higher voltages (IS-2099-1973 para 6.1). In order to avoid breakdown at extremely low pressures the support insulators should not be covered by moisture and conducting dust. Insulators should therefore be extremely clean and should have antitracking properties. Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.5 g in horizontal direction and 0.6g in vertical direction.

13.1.15 OPERATING MECHANISM GENERAL REQUIREMENTS

The operating mechanism shall be stored energy type and capable of giving specified duty of the breaker (sequence of opening and closing) as specified under O-0.3 sec-CO-3 min-CO. The breaker shall also pass the operational test which ascertains the capabilities of operating mechanism. The operating mechanism shall be capable to perform the following functions efficiently.

- i) To provide means where the circuit breaker can be closed rapidly, at all currents from zero to rated making current capacity.
- ii) To hold the circuit breaker in closed position by toggles or latches till the tripping signal is received.
- iii) To allow the circuit breaker to open without delay immediately on receiving tripping signal.
- iv) To perform auto re-closure duty cycle.
- v) To perform the related functions such as indication, contacts, etc.

Operating mechanism should also be suitable for three phase auto re-close duty. The closing spring shall be automatically charged by motor immediately after closing operation. In case of failure of supply to the spring charging motor, the spring shall be chargeable by hand-crank.

a) TRIPPING/CLOSING COILS

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Whereas second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. Provision shall be given for trip circuit supervision both in pre close and post close condition of the breaker. All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch.

b) TRIP FREE FEATURES

When the breaker has been instructed to close by manual instructions using push button, the operating mechanism will start operating for closing operations. If in the meantime a fault has taken place, the relay provision shall be such that it should close the trip circuit simultaneously interrupting the live circuit of closing coil which has been instructed for close command.

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti-pumping device to prevent the circuit breaker from reclosing after an

automatic opening shall be provided to avoid the breaker from pumping i.e., anti-pumping relay should interrupt the closing coil circuit.

c) Controls

The circuit breaker shall be controlled by a control switch located in the control cabinet. The control arrangement shall be such as to disconnect the remote-control circuits of the breaker, when it is under test. Local control devices, selector switch and position indicator shall be located in weather and vermin-proof cabinet with degree of protection not less than IP-55. The circuit breaker control scheme shall incorporate trip circuit supervision arrangement. Local/remote selector switch shall be provided for all breakers for selection of "Local" control/remote control.

Provision shall be made for local manual, electrical and spring controls. Necessary equipment's for local controls shall be housed in the circuit breaker cabinet of weather-proof construction. In addition to this, a hand closing device for facilitating maintenance shall also be provided.

Each circuit breaker shall have a mechanical open/closed and spring charge indicator in addition to facilities for provisions for semaphore indicators for breakers which are required for the mimic diagram in the control room. Lamps for indicating, 'close/open' position of the breaker shall also be provided.

The contact pressure spring and tripping spring shall be chargeable during closing operation to ensure the breaker is ready to open. Mechanically ON/OFF indicator, spring charged indicator and operation counter shall be provided on the front of the control cubicle. For tripping, the spring provided shall ensure the trippings

Mechanical indicator, to show the 'open' and 'close' position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.

Closing coil shall operate correctly at all value of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. The variation in A.C. supply voltage shall be -15% to $+10\%$ while variation in frequency shall be ± 3 . Working parts of the mechanism shall be non-corrosive material. Bearings which require grease shall be equipped with pressure type fillings.

Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.

13.1.16 SPRING OPERATED MECHANISM

The motor compressed spring mechanism shall consist of a closing spring which is wound or compressed by an

electric motor immediately after the breaker closes.

After the breaker has tripped, the tripping spring shall remain in the released position as long as the breaker is open, but the closing spring shall remain wound and ready for closing operation. The operating mechanism shall have all the necessary auxiliaries, apparatus for operation and supervision, like motor starter with thermal overload release, one closing coil, two trip coils, push button for local electrical operation, local/remote control selector switch, push button for direct mechanical tripping, auxiliary switches, anti-pumping contactors, operation counter, socket for inspection, lamp and heater with switch. Spring charging motor shall be standard single phase universal motor suitable for 220 volts supply.

- i) Operating voltages for closing/tripping coils shall be 220/110/48/24 Volts DC **or as per actual DC voltage available at existing substations which is to be verified by supplier after award of contract.**
- ii) Operating voltages for heater elements shall be 220V AC 50 HZ. Other features of the spring-operated mechanism shall be as follows.
 - a) The spring operating mechanism shall have adequate energy stored in the operating to close and latch the circuit breaker against the rated making current and also to provide the required energy for tripping mechanism in case the tripping energy is derived from the operating mechanism.
 - b) The mechanism shall be capable of performing the rated operating duty cycle of O-0.3Sec-CO-3 Min-CO...
 - c) The spring charging motor shall be AC or DC operated and shall not take more than 30 sec., to fully charge the closing spring made for automatic charging. Charging of spring by the motor should not interfere with the operation of the breakers.
 - d) The motor shall be adequately rated to carry out a minimum of one duty cycle. Also, provision shall be made to protect the motor against overloads.
 - e) In case of failure of power supply to spring charging motor, the mechanism shall be capable of performing one open-close-open operation.
 - f) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in closed position. Provision shall be made to prevent a closing operation to be carried out with the spring partially charged.
 - g) Facility shall be provided for manual charging of closing springs.
 - h) Spare contact of spring charge indication shall be provided.

13.1.17 CONTROL CABINET

The switchgear operating mechanism, the control equipment such switch for closing and tripping the breakers, various control relays, anti-pumping device, a set of terminal blocks for wiring connections, MCB's for disconnecting the control auxiliary power supplies including relays, etc., shall be enclosed in a cabinet to be mounted on a suitable structure at a convenient working height at the end of the breaker in the outdoor switchyard. The supporting structure and the enclosure shall be capable of withstanding the typical tropical climatic conditions, change of ambient temperature, severe dust-storms, very high relative humidity those are prevailing at the site of location of switchgear.

i) ENCLOSURE

The enclosure shall be made out of stretched level steel plates not less than 3 mm thick and of light section structural steel (CRCA). It should be weather proof as well as vermin proof.

The enclosure shall provide protection against dust and foreign objects. Each cabinet section shall have full width and full-length hinged doors mounted on the front that swing fully open. The doors shall be provided with latches to securely hold it with the cabinet. Doors shall be of sturdy construction, with resilient material covering, fully perimetrically contacting the cabinet frame to provide dust protection and prevent metal to metal contact except at the latch points. Filtered ventilation shall be provided along with the rigid supports for control and other equipment, measuring instruments, mounting cabinet members and equipment shall not restrict easy access to terminal blocks for terminating and testing external connection or to equipment for maintenance.

All screws and bolts used for assembling and mounting wire and cable termination, supports, devices and other equipment shall be provided with lock washers or other locking devices. All metal parts shall be clean and free of weld splatter, rust and mill scale prior to application of double coat of zinc chromate primer which should be followed by an under coat to serve as base and binder for the finishing coat. The shade of exterior and interior shall be as per GTR. The mounting structure shall be galvanized and shall be as per IS- 802-II-1978.

ii) HEATERS

Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by thermostat and shall be provided with ON/OFF switches and fuses. Heaters shall be suitable for 240 V AC supply voltage.

iii) LIGHTING

At least one 13-watt CFL fixture and lamp working on 240 V 50 c/s AC supply shall be provided in each switchgear control cubicle section and shall be located suitably to provide adequate interior lighting of the cubicle. A single-pole 6 Amp. lighting switch shall be provided for each cubicle along with 5/15 amp.

The lighting and convenient outlet circuits shall be completely wired in conduit and terminated on cubicle terminal blocks.

iv) WIRING AND CABLING

- a) Unless otherwise specified control wire shall be stranded tinned armoured copper switchboard wire with 1.1 kVPVC insulation conforming to the requirements of IS-1554.
- b) All the control circuit and secondary wiring shall be wired completely and brought out to terminal block ready for external connections in the control cabinet. The cross-section of control wire shall not be less than 2.5 mm² copper (14 SWG).
- c) All spare auxiliary contacts of the circuit breaker shall be supplied wired up to terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm² copper conductor.
- d) All wiring termination on terminal blocks shall be made through lugs.
- e) All wires shall be identified with non-metallic sleeve or tube type markers at each termination.
- f) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers. Disconnecting type terminal blocks will be provided.

v) GROUNDING

A ground bus of GS bar not less than 10 mm by 50 mm shall be provided for grounding the cabinet.

13.1.18 ACCESSORIES

Each circuit breaker assembly shall be supplied with the following accessories.

- i) Line and earthing terminals and terminal connectors.
- ii) Control housing with:
 - a) One auxiliary switch with adequate number of auxiliary contacts, but not less than 24 nos. (12 NO + 12 NC) for each breaker. These shall be over and above the No. of contacts used for closing, tripping and re-closing and interlocking circuit of the circuit breaker. All auxiliary contacts shall be capable of use as "Normally closed" or "Normally open" contacts. Special auxiliary contacts required for the re-closing circuit if any, shall also be provided. There shall be provision, to add more auxiliary contacts at a later date, if required.
 - b) Operation counter
 - c) Position indicator (Close/Open)
 - d) Necessary cable glands
 - e) Fuses
 - f) Manual trip device and local test push buttons
 - g) Terminal blocks and wiring for all control equipment and
 - h) Adequate number of heaters for continuous operation to prevent moisture condensation in the housing of operating mechanism
 - i) Selector switch for local/remote control.

13.1.19 SUPPORTING STRUCTURE

The circuit breakers shall be supplied complete with necessary galvanized steel supporting structures, foundation and fixing bolts, etc., the galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be 4000 mm from finished ground level.

The bidder shall submit detailed design calculations and detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

13.1.20 SURFACE FINISH

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulation oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

13.1.21 GALVANISING

All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS:2629 or any other equivalent authoritative standard.

13.1.22 CABLE TERMINATION

Suitable cable glands for terminating the multicore cable, shall be provided wherever required.

13.1.23 TERMINAL CONNECTIONS AND EARTH TERMINALS

Each circuit breaker connected with incoming and outgoing feeders shall be provided with solderless clamp type connectors suitable for ACSR conductor (as per site requirement).

Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

13.1.24 INTERLOCKS

Necessary interlocks to prevent closing or opening of the breaker under low pressure of the contact spring and devices for initiating alarm shall be provided. The detailed interlocking scheme based upon single line diagram as applicable for the substation shall be provided by the contractor

Requirement of interlock shall be as given below:

- i) Isolator should not be operated unless the associated breaker is in open position.
- ii) The circuit breaker shall close only after all isolators associated with it have been in closed position.

In case of double bus bar arrangement following additional requirement for interlocking shall be provided.

- i) One bus bar selector isolator of any bay excepting the bus coupler bay shall close only when,
 - a) The circuit breaker of corresponding bay is open and locked.
 - b) The other bus isolator of that bay is open.
- ii) When one bus isolator of any bay excepting the bus coupler bay is closed. The other shall close only when the bus coupler circuit breaker and both the bus isolators are closed.
- iii) Bus isolator of bus coupler bay shall operate only when the bus coupler breaker is open.
- iv) The bypass isolator of feeder shall close when the feeder circuit breaker and its adjoining isolators are closed.

13.1.25 EARTHING SYSTEM

All switchgear enclosures should be bolted metal to metal and should carry the full earth return current. Connection between phases at the earthing points shall be dimensioned for carrying full earth return current i.e., actual service current not rated current.

13.1.26 VACUUM INTERRUPTER ASSEMBLY

Each pole of the circuit breaker shall be provided with vacuum interrupter, one for each phase, hermetically sealed for life and encapsulated by ceramic insulators. The interrupter shall be provided with steel chromium arc chamber to prevent vaporized contact material being deposited on the insulating body. A further shield giving protection to the metal bellows shall also follow the travel of the moving contacts to seal the interrupter against the surroundings atmosphere.

It shall have high and consistent dielectric strength of vacuum unaffected by environment and switching operations. Bronzed joints should ensure retention of vacuum for life time. It shall have low and stable contact resistance due to absence of oxidation effects and shall ensure low power loss. The arcing voltage shall be low and minimum contact erosion.

13.1.27 GUARANTEED TECHNICAL PARTICULARS

Guaranteed and technical particulars as called for in Section-II shall be furnished along with the tender. Particulars which are subject to guarantee shall be clearly marked.

13.1.28 TEST TYPE TESTS

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No. 62271-100

- i) Short time and peak withstand current test.
- ii) Short circuit breaking capacity and making capacity.
- iii) Capacitive current switching test: Cable charging current breaking test (I_{ur} less than or equal to 52kV).
- iv) Dielectric test i.e., power frequency withstand and impulse withstand test
- v) Temperature rise test.
- vi) Mechanical Endurance Test at ambient temperature.
- vii) Measurement of resistance of the main circuit.

ROUTINE TESTS

Routine Tests as per IEC- 62271-100 shall be carried out on each breaker in presence of purchaser's representative at the manufacturer's expenses at his works except, where agreed to otherwise. All test reports should be submitted and should be got approved from the purchaser before despatch of the equipment.

SITE TESTS ON CONTROL AND AUXILIARY CIRCUIT

The following tests shall be conducted at site.

- i) Voltage tests on control and auxiliary circuit.

- ii) Measurements of resistance of the main circuit.
- iii) Mechanical Operation Tests.

13.1.29 NAME PLATE

Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant ISS or other specification stipulated.

13.1.30 TECHNICAL PARAMETERS 36 KV CIRCUIT BREAKERS

S. NO.	DESCRIPTION	VALUES
i)	Rate voltage (KV rms)	: 36 KV
ii)	Rated frequency (Hz)	: 50
iii)	System neutral earthing	: Solidly grounded system
iv)	Type of arc quenching medium	: Vacuum
v)	Rated normal current at site conditions (Amps)	: 1250 Amps (as per BOQ)
vi)	Number of poles	: 3
vii)	Installation	: Outdoor type
viii)	Temperature rise	: As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit	:
	a) Interrupting capacity at 36 KV	: 31.5 kA
	b) The percentage DC components	: As per IEC-62271-100
	c) Duration of short circuit	: 3 Sec.
x)	Rated short circuit making	: 78.75 KA
xi)	First pole to clear factor	: 1.5
xii)	Rated short time current	: 31.5 KA
xiii)	Rated duration of short circuit	: 3 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	: < 80 ms
xv)	Closing time (ms)	: < 150 ms
xvi)	Mounting	: Hot dip galvanized lattices steel support structured bolted type
xvii)	Phase to phase spacing in the switch yard i.e, interpole spacing for breaker (min) in mm	: 470±10
xviii)	Required ground clearance from the lowest line terminal if both the terminals are not in same horizontal plane (mm)	: 4000
xix)	Height of concrete plinth (mm)	: 150
xx)	Minimum height of the lowest part of the support insulator from ground liner (mm)	: 3194
xxi)	Minimum creepage distance of support insulator (mm)	: 1116

S. NO.	DESCRIPTION	VALUES
xxii)	Minimum corona extinction voltage (kv rms)	: 92
xxiii)	Standard value of rated transient recovery voltage for terminal fault	: As per IEC-56
xxiv)	Standard value of rated line Characteristics for short line faults	:
	RRRV	: KV/ms=0.214
	Surge Peak Factor	: K=1.6 A
	Impedance	: 450
xxv)	Rated operating duty cycle	: O-0.3 Second - CO-3 Minutes-CO
	b) Auto reclosing	: Suitable for three phase Auto reclosing duty
xxvi)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightening Impulse withstand voltage (KV peak)to earth	: 170 KV
xxvii)	Power frequency withstand voltage KV (rms) to earth (KV rms)	: 70 KV
xxviii)	Rated characteristic for out of Phase breaking	:
	a) Out of phase breaking capacity	: 25% of rated breaking capacity
	b) Standard values of transient recovery	: As per IEC-56
	c) Operating mechanism	: Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	: Three phase 415 Volts 50 C/S or single phase 50 C/S 240 volts
xxix)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	: 1)220 V DC/110V VDC 2)240 Volts AC 50 C/S single phase 3)415 volts 50 Hz three phase
	b) Permissible voltage variation	: 1)In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage. 2)In case of AC power supply voltage variation shall be of the normal voltage as per IS-15% to +10%.
	c) Permissible frequency	: $\pm 3\%$ from normal 50 Hz as per IS 2026 part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	: $\pm 10\%$
xxx)	Auxiliary contacts (number & rating)	: 12 NO and 12 NC on each pole having continuous current rating of 10 Amps. DC breaking rating capacity shall be 2 Amps with

S. NO.	DESCRIPTION		VALUES
			circuit time constant less than 20 ms at 220/30 volts DC
xxxi)	Number of trip coils	:	Two trip coils and 1 close coil with anti-pumping arrangement
xxxii)	Rated terminal load	:	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces
xxxiii)	Noise level of the equipment	:	Not exceeding 140 db
xxxiv)	Class of breaker	:	M2-E2-C2
xxxv)	Ladder	:	Necessary platform with ladder shall be provided for local operation/maintenance to ease out accessible reach
xxxvi)	Galvanisation Thickness of Supporting structure	:	125 microns

14. DRAWINGS AND INSTRUCTION MANUALS

Following drawings for each item are to be supplied as part of the contract.

- i) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.
- ii) Outline drawing of bushings showing dimensions and number of sheds and creepage distance.
- iii) Assembly and sub-assembly drawings with numbered parts.
- iv) Sectional views showing the general constructional features, operating mechanism and arc extinguishing chamber, etc.
- v) Dimension and assembly of important auxiliaries.
- vi) Detailed drawings of operating mechanism. And inter-phase mechanism.
- vii) Test certificates.
- viii) Detailed drawings of mounting structure.
- ix) Spare parts and catalogue
- x) Wiring diagram showing the local and remote-control scheme of breaker including alarms indication devices instruments relay and timer wiring.
- xi) Write up on working of control schematic of breaker.
- xii) Foundation plan including weights of various components and impact loadings for working foundation design. Three copies for each pkg. of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.