BIDDING DOCUMENT FOR

TURNKEY CONSTRUCTION OF 2X50 MVA, 132/33KV GIS (GAS INSULATED SUBSTATION) AT EXISTING 220/132KV AMINGAON GIS

FUND: "North East Special Infrastructure Development Schemes (NESIDS)"

(E-Tender)
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VOLUME-2

TECHNICAL SPECIFICATION

BID IDENTIFICATION NO:
AEGCL/MD/Tech-868/Amingaon GIS/2022/Retender/BID

ASSAM ELECTRICITY GRID CORPORATION LIMITED

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, erection, testing & commissioning and setting to work of construction of new substations 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

(a) <u>Project Details:</u>

Sl. No.	Description
1	TURNKEY CONSTRUCTION OF 2X50 MVA, 132/33KV GIS (GAS INSULATED SUBSTATION) AT EXISTING 220/132KV AMINGAON GIS

(b) Scope of Works: - The brief scope of works are as follows:

- Design, Supply, Erection, Testing and Commissioning of two nos. of 132kV GIS bays for 2x50MVA 132/33kV transformers and Extension of existing 132kV GIS Bus in the existing GIS Hall of 220/132 kV Amingaon GIS as per tender drawings and BoQ along with GIS duct drawn up to HV side of transformers, associated support structures, SF6 to Air Bushing, associated Civil Works, Earthing of GIS Modules etc and other job necessary for complete ETC of the Transformer GIS Bays.
- Design, supply, erection, testing and commissioning of 2X50 MVA, 132/33KV transformers along with other AIS Equipment like Surge Arrestors, Cable Termination etc along with support structures and associated civil works like design and construction of transformer Pad, Sump Pit, Earthing, gravelling, foundation works of Equipment structures etc and other job necessary for complete ETC of the Transformer and HV/LV Bays.
- Design, supply, erection, testing and commissioning of 33KV indoor VCBs with inhouse bus bars, panels etc. along with construction of 33 kV control room building, Cable Trenches and incoming/outgoing 33kV Bays as per tender drawings and BoQ, complete with design, supply and ETC of AIS Equipment, Support Structures, Gantry Structures, associated civil works, Earthing works and other job necessary for complete ETC of 33kV Bays.
- Design, supply, erection, testing and commissioning of CRPs as per Tender drawings, documents and BoQ along with integration with the Existing SAS.
  Integration of Line and Transformer Bays under present scope with existing Sub Station Automation System for MHMI and RHMI: The scope of the Bidder shall include but not limited to integration of IEDs under present scope of construction with the existing substation automation as per tender drawings and documents, which is based on IEC 61850 and capability enhancement of same as required including up-dating of system database, displays, development of additional displays and reports for all signals related

to Transformer, Bays etc. as per requirement. Furthermore, supply of Ethernet switches and other equipment for integration with existing SAS shall be included in the scope of the Contractor.

All SAS integration work should be carried out in presence of existing SAS OEM authorized personnel, arrangement of SAS OEM authorized personnel under the scope of the contractor.

Any upgradation of hardware and software for above integration shall be in the scope of contractor including license upgradation (if any). Validity of upgraded license should be minimum 10 years.

- Extension of Switchyard, extension of Earthing mat, Lighting arrangements, Lightning Protection etc
- Construction of roads, trenches, drains and other related civil works etc.

(c) The present scope of work is briefly described as below:

Following transmission system is envisaged at 132/33 kV Amingaon (Dist:Kamrup (Rural)S/S:

A) **<u>Transformer & Reactors</u>**

- Transformer: 2X50 MVA,3-ph, 132/33kV

<u>132kVGISBays:</u>

- ICT bays:2nos. (HV side of 132/33, 2x50MVA transformers)

<u>33kV Indoor VCB panel</u>

- ICT bays: 2 nos. (LV side of 132/33, 2x50MVA transformers)
- Line bays: 8 nos.
- Bus Sectionalizer bays: 1 no
- Bus PT bay: 2 nos.

B) Integration of Transformer and Feeder bays with existing SAS

C) Civil Works as per Tender drawings & Documents and BoQ

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 Supply of 132/33 kV Power Transformers is in the scope of this bidding document. The erection, testing and commissioning of power transformers including construction of transformer pad is under the scope of the Contractor.

1.2.3 The scopes of works also include site development, construction of Control Room Building and other facilities at substations as specified in the Bidding Document.

1.2.4 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 Employer. The Employer 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. The complete Drawings and the Designs will be prepared by the Contractor and shall be submitted to AEGCL for approval.

1.2.5 Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as a part of the Bidder's scope, unless and until mentioned very clearly as excluded.

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

i) Supply of all substation switchgears, control gears and protection equipment as per bidding document.
ii) Erection, testing and commissioning of power transformers along with all switch & control gears such as circuit breakers, isolators, current transformers, relay & control panels, SAS, RTU with accessories and cables, Lightning Arrestersetc. as specified in Bill of Materials.
iii) Supply, erection, testing and commissioning of Substation Automation Equipment as specified in Bidding Document.
v) Supply and erection of substation steel structure.
vi) Construction of cable trenches and earth mat including supply of all materials.
vii) Construction of Control Room Building as per Specification & Drawings; and providing illumination, sanitary and water supply fittings including supply of all materials.
viii) Other works includes site development, construction of equipment and structure foundations, supply & installation of Security Fencing, Design and installation ofillumination system for switchyard etc. as brought out in the Specification and Schedule of Requirements.

1.2.7 The work involves design (as applicable), engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, civil foundation work, erection and commissioning at site.

1.2.9 The name of substation that is to be built under the scope of this specification is **Amingaon Substation**, the site is located in **Pacharia, Kamrup (Rural) Distric**t of Assam.

1.2.10 The various items of works are described very briefly in the schedule of Bid Form, Prices & Other Schedules and Annexures. 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.

1.2.11 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, who 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.

1.2.12 Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as apart of the bidder's scope supply, unless and until mentioned very clearly in exclusions.

1.2.13 The rates quoted shall include minor details which obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

1.2.14 The rates quoted shall be inclusive of all plant equipment, men, material, skilled & unskilled labour etc. essential for satisfactory completion of various works.

(A) All measurements for payment shall be in SI Units; lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square metres and volume in cubic metres, rounded off to two decimal places.

1.2.16 This specification includes supply of hardware fittings and all type of accessories for Conductor and earthwire as detailed in the specification. Contractor shall clearly indicate in their offer, the source from where they propose to procure these materials in appropriate schedule of Bid Form, prices & other schedules. The technical description of these items is given in subsequent sections of this volume.

1.2.17 All raw material such as Structural Steel, Zinc for Galvanizing, reinforcement steel and cement for tower foundations, coke and salt for tower earthing, conductor / earth wire, insulators, line hardware etc. bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase/ number plates etc. required for tower manufacture and erection shall be included in the contractor's scope of supply. Bidders shall clearly indicate in their offer, the source from where they propose to procure the raw materials and the components.

1.2.19 The Bidder's rates shall be based on the description of activities in the schedules as well as necessary operations detailed in Technical Specifications.

1.2.20 ***The tentative Bill of Quantities are furnished in Annexure-I, Annexure-II, Annexure-III, Annexure-IVat the end of this Section. Bidders are requested to note the following points:***

i) ***The items mentioned in these Annexures shall only be used while preparing the Price Schedules. If any items which is not specifically mentioned in Annexure- I, Annexure-II&Annexure-III; but required to complete the works as per Specification shall deemed to be included in any of the items of these Annexure. Additions, deletions, or modification of these items while preparing the Price Bid by the Bidder shall render his bid non responsive.***

ii) ***The quantities are provisional in nature and for bidding purpose and for bid comparison purpose only. Quantities may vary to the extent of (+) 20 % to (-) 20% in terms of total Contract Price.***

1.3.0 CONTRACTOR TO INFORM HIMSELF FULLY

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

1.3.2 The Employer 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 Employer

1.4.0 SERVICE CONDITIONS

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

a)	Peak ambient day temperature in still air	: 45ºC
b)	Minimum night temperatures	: 0ºC
c)	Reference ambient day temperature	: 45ºC

d) Relative Humidity a) Maximum :100%

b) Minimum:10%

e) Altitude: Below1000 M above MSL

1.5.0 ACCESS TO THE LINE AND RIGHT OF WAY

Right of way and the way leave clearances shall be arranged by the Employer in accordance with the work schedules. Employer will secure way leave and right of way in the Forest area also (if any). However, it is responsibility of the Contractor to clearing of all obstacles along the right of way of the transmission line routes, like cutting of trees, jungles etc. The Bidder shall include the cost of this works in rates quoted for survey/erection/stringing of the lines.

1.6.0 Basic System Data;

SL. No	Description	132 KV
1.	Nominal system voltage KV rms	132
2.	Highest system voltage KV rms	145
3.	System of grounding	Solidly Grounded
4.	Impulse insulation level KV peak	650
5.	Power frequency withstand voltage (wet) KV rms	260
6.	Protective shielding angle against direct lightning	NOT EXCEEDING 30^0
7.	Creepage Distance	27 mm/ KV
8.	Minimum Corona extinction voltage at 50Hz AC system Dry condition (phase to earth)	Not less than 154 Kv

1.8.0 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS:

1.8.1 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.

1.8.2 The Contractor shall also comply with the Minimum Wages Act 1948 and the payment of Wages Act (both. of the Government of India and State of Assam) and the rules made there under in respect of any employee or workman employed or engaged by him or his Sub-Contractor.

1.8.3 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the statutory laws and its amendments from time to time during erection in respect of the Substation Works, ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.

1.9.0 STANDARDS

1.9.1 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.

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

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

1.10.0 CONTRACTOR'S REQUIREMENT

1.10.1 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.

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

1.11.0 ENGINEERING DATA

1.11.1 The furnishing of engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer 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 Employer 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.

1.11.2 All engineering data submitted by the Contractor after review by the Employer shall or part of the contract document.

1.12.0 DRAWINGS AND DOCUMENTS FOR APPROVAL

1.12.1 In addition to those stipulated in clause regarding drawings in General Conditions of Contract (Volume-1), the following sub clauses shall also apply in respect of Contract Drawings.

1.12.2 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.

1.12.3 Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, 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.

1.12.4 The drawings submitted for approval to the Employer shall be in quadruplicate. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections"' if found in generally in accordance with the specification. Initial submitted drawings may be in soft copies forwarded through e-mails. However, in this case drawings must be in 'Autocad' file formats.

1.12.5 The contractor shall there upon furnish the Employer additional prints as may be required along with Soft Copies (in Autocad file formats) of the drawings after incorporating all corrections.

1.12.6 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.

1.12.7 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.

1.12.8 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.

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

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

FOR SUB-STATION

a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.

b) General Layout of Switchyard: Plan and Sections.

c) Drawings for Control Room including elevation, sections etc.

d) Earthing layout and details.

e) Cable Trench Layout and details.

f) Foundation layouts and details of main and auxiliary structures.

g) Cable Schedule, as applicable.

h) Design and layout of illumination system for control Room and Switchyard.

i) Detail design calculations and drawings for buildings, structures, equipment supports, foundations, transformer pad, eyc., as asked for in the specification.

j) For equipment and items in the scope of supply:

i) General arrangement drawing with full dimensions.
ii) Electrical schematic diagram, where applicable.

iii) Wiring diagram, where applicable.

iv) Architecture of SAS.

1.12.11 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.

1.13.0 FINAL DRAWINGS AND DOCUMENTS

1.13.1 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).

1.13.2 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.

1.14.0 APPLICATION AND SYSTEM SOFTWARE

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

1.15.0 DESIGN IMPROVEMENTS

1.15.1 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.

1.16.0 DESIGN CO-ORDINATION

1.16.1 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 co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.17.0 DESIGN REVIEW MEETING

1.17.1 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.

1.18.0 QUALITY ASSURANCE, INSPECTION & TESTING

1.18.1 **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.

1.18.2 **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 representative 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.

1.19.0 **EMPLOYER'S SUPERVISION**

1.19.1 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.

1.19.2 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.

1.20.0 INSPECTION & INSPECTION CERTIFICATE

1.20.1 The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer 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.

1.20.2 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 Employer/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.

1.20.3 If desired by the Employer, the Contractor shall also carry out type tests as per applicable Standards for which Employer 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.***

1.20.4 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.

1.20.5 **Tests**

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

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

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

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

iv) Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the 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 Employer.

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

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

1.21.0 TEST REPORTS

Equipment, which has 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.

1.21.1 All Bids must be accompanied by the Type/Performance Test Certificates of equipment offered (refer *Clause 1.21.4* below). Such type test certificates shall be acceptable only if: -

(a) Tests are conducted in an independent and well-known testing laboratory, *or*

(b) 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 clients or purchaser.

1.21.2 Test reports to be acceptable must be related directly to the equipment offered i.e., it is fully identical in design, rating and construction with the equipment for which the type test certificates have been submitted. Test reports for of similar equipment /materials are acceptable with commitment to perform the type/performance tests free of any charge on the particular equipment after the award of contract.

1.21.3 Type Test Reports older than ten (10) years on the date of technical bid opening shall not be accepted.

1.21.4 Full Type Test /Performance Test Reports of at least the following equipment must be submitted along with the Bid: -

(A) For Sub-Station (all voltage classes as applicable): -

1. Power Transformer
2. Circuit Breaker
3. Current & Potential Transformers
4. Lightening Arrester
5. Motorised Isolators
6. Numerical Relays (in addition to type tests KEMA Certificate for GOOSE Messaging & Publishing are to be submitted)
7. BCU and Substation Automation System
8. Gateway/ Ethernet switches

1.22.0 SPARE PARTS

1.22.1 Recommended Spare Parts

The Bidder shall also furnish if asked for in Bidding Forms, an item wise list of recommended spare parts and quantity for three years satisfactory operation of the equipment with unit price of each part in a separate Schedule. Prices of these spare parts shall not be taken in to account in comparing Price Bid Also, they will submit an undertaking to supply all spare parts for a minimum period of 10 (ten) years as and when any request is made before them on a chargeable basis.

1.22.2 Mandatory Spare Parts

The Bidder shall also quote for the mandatory spares as listed in Annexure-I this Section.

Prices of these spare parts shall be taken into account in comparing price Bid.

1.23.0 GUARANTEED TECHNICAL PARTICULARS

1.23.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in the prescribed schedules of this Specification (SECTION-14)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.

1.23.2 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 were stated otherwise.

1.24.0 PACKING

1.24.1 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.

1.24.2 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.

1.24.3 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.

1.24.4 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.

1.24.5 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.

1.25.0 CONSTRUCTION TOOLS, EQUIPMENTS ETC.

1.25.1 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.

1.26.0 MATERIALS HANDLING AND STORAGE

1.26.1 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.

1.26.2 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.

1.26.3 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.

1.26.4 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.

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

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

1.26.7 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.

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

1.27.0 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

1.27.1 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.

1.27.2 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.

1.27.3 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.

1.28.0 COMMISSIONING SPARES

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

1.28.2 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 unutilised 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.

ANNEXURE–I

SCHEDULE OF QUANTITY (SUPPLY)(SUB-STATION)

(Note: Items and Sub items shown in this Annexure shall only be used in preparing Price Bidding Schedules. Any other items not specifically mentioned here under are Deemed to be included in other Items)

Sl. No.	Item Description	Quantity	Units	Unit ExWorks (exclusive of taxes) In Figures To be entered by the Bidder in Rs. P	TOTAL AMOUNT (Without Taxes) in Rs. P
1	2	4	5	13	53
1	**Supply of 132kV GIS Equipments(Supply A)**				
1.10	145kV, 3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed Transformer bay module each set comprising of One (1) number 3-phase, 3150A, SF6 insulated circuit breaker complete with operating mechanism; Three (3) numbers 1-phase, 5-core, multi ratio,600-300/1-1-1-1-1A current transformers; Three (3) numbers 3-phase, 3150A, group operated isolators/disconnectors, complete with manual and motor driven operating mechanisms; One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms; Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required; Local Bay control cubicle.(Stand Alone or Integrated)	2	Sets		**0.00**
1.20	Three phase, 3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed bus bar of 145kV, each set comprising of Bus bars enclosures running from the existing Bus bar Module to interconnect each of the Transformer circuit breaker bay modules in Double Bus bar configuration; Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required	2	Sets		**0.00**

1.30	145kV, 3150A, 40 kA for 4 sec, 3- phase SF6 to air bushings along with termination module & support structure for outdoor connections to connect GIS with 145kV side of Power transformer.	2	Sets		0.00
1.40	145kV, 3150A, 40kA for 4 second, 3-Ph encapsulated, SF6 Gas Insulated Bus Duct (GIB) outside GIS hall including Bus Duct support structure and associated accessories along with jointing elements	75	RM		0.00
1.50	Erection Hardware for 145kV GIS Termination arrangement for Transformer bay Modules	2	Nos		0.00
2.00	**Supply of outdoor bay equipments (Supply B)**				
2.01	**Transformer**				
2.02	50 MVA, 132/33 kV, 3-Ph, YNyn0, Z =12.5 %, ONAN/ONAF with copper wound Power Transformer with OLTC(+5% to -15% in steps of 1.25%) , RTCC panel including all cabling, insulating oil for the transformer plus 10% spare oil, supplied with Bushing mounted NCT on HV & LV side & complete with all fittings and accessories to meet the technical specification including cost of all routine test including loading and unloading at site.The Transformer shall be suitable for 4" Aluminium Tubular Conductor termination on HV and LV side.	2	No		0.00
2.03	Online DGA	2	No		0.00
2.04	Online Insulating oil drying system	2	Sets		0.00
2.05	**Lightning Arrester**				
2.06	120 kV, 10 kA, Metal Oxide type, heavy duty, station class 3, Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		0.00
2.07	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		0.00

2.08	**Supply of 33kV XLPE Cable and Termination Kit**				
2.09	1000 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories	200	Mtr		**0.00**
2.10	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories.	4	Set		**0.00**
2.11	33kV Support Structure for Outdoor Cable Termination Kit	2	Nos		**0.00**
2.12	**LT Power Cable (1.1kV grade)**				
2.13	(i) 2C, 6 mm2	400	Mtr		**0.00**
2.14	(ii) 4C, 16 mm2	400	Mtr		**0.00**
2.15	(iii) 3½ C, 35 mm2	400	Mtr		**0.00**
2.16	(iv) 3½ C, 70 mm2	400	Mtr		**0.00**
2.17	(v) 3½ C, 300 mm2	400	Mtr		**0.00**
2.18	(vi) Cable Supports and fittings	1	LS		**0.00**
2.19	**LT Control Cable**				
2.20	(i) 4C, 2.5 mm2	250	Mtr		**0.00**
2.21	(ii) 7C, 1.5 mm2	250	Mtr		**0.00**
2.22	(iii) 12C, 1.5 mm2	250	Mtr		**0.00**
2.23	(iv) 19C, 1.5 mm2	250	Mtr		**0.00**
2.24	**Earthing**				
2.25	Main Earthing Conductor 40mm dia MS Rod	600	meter		**0.00**
2.26	Earthing Conductor: 40mm dia MS Rod For Riser From The Burial Earth Mat To Equipment,Structure Etc)	600	meter		**0.00**
2.27	Earthing Conductor: 75X12mm GI Flat For Equipment and Structure Earthing	300	meter		**0.00**

2.28	Earthing Conductor: 50X6 mm GI(HDG) Flat For Riser For Console Box,Lt Panels,Dc Panels,Marshalling Boxes, Cable Trenches Etc)	150	meter		**0.00**
2.29	Earthing Device & Associated Accessories (50 mm Heavy Duty GI Perforated Pipe 3 Mtrs Long For Treated Earth Pit)	6	Nos.		**0.00**
2.30	Earthing Device & Associated Accessories 40 mm Ms Rod 3 Mtrs Long for Non Treated Earth Pit)	60	Nos.		**0.00**
2.31	Separate Earthing For 145 Kv GIS Modules	1	JOB		**0.00**
2.32	Separate Earthing For 145 Kv GIS Building	1	JOB		**0.00**
2.33	Separate Earthing For 36 Kv Indoor AIS Equipment	1	JOB		**0.00**
2.34	Separate Earthing For 36 Kv Indoor AIS Building	1	JOB		**0.00**
2.35	Other Earthing Accessories	1	Lot		**0.00**
2.36	**Fire Protection System for Transformer**				
2.37	**NIFPS**				
2.38	N2 Fire Prevention and extinguishing System for transformer with complete accessories and related Civil and Electrical works.	2	No		**0.00**
2.39	**HVWS**				
2.40	HVW spray system, Hydrant System and complete U/G and O/G Piping and accessories etc and associated Civil Works for fire protection system for 2 nos 50 MVA 132/33kV Transformer	1	Set		**0.00**
2.41	HVWS System for 50 MVA ICT	2	Set		**0.00**
2.42	**Portable/Wheel/ Trolley mounted Fire Extinguishers**				
2.43	22.5 Kg capacity FE CO2 type, Trolley Mounted	4	Nos		**0.00**
2.44	25 Kg Capacity FE DCP type, Trolley Mounted	4	Nos		**0.00**
2.45	DCP 10 Kg Capacity, Wall mounted	6	Nos		**0.00**

2.46	FE CO2 6.5 Kg capacity, Wall mounted	4	Nos		**0.00**
2.47	DCP 5 Kg Capacity, Wall mounted	5	Nos		**0.00**
2.48	Foam Type 9-liter Capacity, Wall mounted	4	Nos		**0.00**
2.49	Water CO2 9-liter, Wall mounted	6	Nos		**0.00**
2.50	Fire Buckets (12 Nos. with stand in one set)	1	Set		**0.00**
2.51	**Supply of indoor floor mounted, SIMPLEX type control and relay panels, with mimic & annunciation panel for 132kV system as per specification comprising of the C & R panels and shall be complete with Numerical Relays and SAMAST Compliant ABT meters as per the technical specifications & shall be compatible for SCADA/SAS.**				
2.52	**132kV Panels**				
2.53	Transformer Protection Panel	2	No		**0.00**
2.54	**Substation Automation System**				
2.55	Complete Sub Station Automation System for 132/33kV GSS Transformer Bays including Hardware and Software for the substation and remote-control stations alongwith associated equipments for the transformer bay	2	Nos		**0.00**
2.56	Integration with the existing SAS system	1	LS		**0.00**
2.57	**Conductor / IPS Al Tube**				
2.58	4" IPS Al Tube	80	Mtr		**0.00**
2.59	**Lightning protection**				
2.60	Lightning Mast (LM)- 40m	1	No		**0.00**
2.61	**Illumination system for Outdoor Lighting (Switchyard and Street lighting)**				
2.62	Lighting Panel				
2.63	Lighting Panel Type ACP-2	1	Nos		**0.00**

2.64	Sub lighting panel type SLP	2	Nos		**0.00**
2.65	lighting Fixtures and Receptacles including junction box, lighting wires and flexible conduit (if required) from junction box to lighting fixture, mounting arrangement and other accessories/ materials etc as required for complete installation and commissioning of lighting fixture				
2.66	Lighting Fixture Type SF1	4	Nos		**0.00**
2.67	Lighting Fixture Type SF2	2	Nos		**0.00**
2.68	Lighting Fixture Type SF4	2	Nos		**0.00**
2.69	Mandatory Spare Parts				
2.70	**For 132/33KV,50MVA Transformers**				
2.71	145kV H.V. Bushing with metal parts and Gaskets	2	No		**0.00**
2.72	HV side neutral bushing	2	No		**0.00**
2.73	36KV LV bushing	2	No		**0.00**
2.74	36kV Neutral Bushing with metal parts and gaskets	2	No		**0.00**
2.75	Local and remote winding temperature indicators with alarm and trip contacts and maximum reading pointer	2	Set		**0.00**
2.76	Oil temperature indictor with alarm and trip contacts and maximum reading pointer	2	Set		**0.00**
2.77	Pressure relief device for main tank	4	Set		**0.00**
2.78	Pressure relief device for OLTC	4	Set		**0.00**
2.79	Silica Gel/ Maintenance free breather assembly (one of each type) for Conservator and OLTC	2	Set		**0.00**
2.80	Magnetic oil level gauge with low oil level alarm contacts	2	Set		**0.00**
2.81	Oil Flow indicator with contacts	2	Set		**0.00**
2.82	Coller Pump with Motor	2	Set		**0.00**
2.83	Cooler fan with motor.	4	No		**0.00**

2.84	Buchholz relay.	4	No		**0.00**
2.85	Tap position Indicator (Local and remote)	2	No		**0.00**
2.86	Oil Sampling Bottle	4	No		**0.00**
2.87	Oil Surge Relay	4	No		**0.00**
2.88	Complete set of gasket (complete set for one transformer)	2	Set		**0.00**
2.89	Set of valves (complete set for one transformer)	2	Set		**0.00**
2.90	**For 132KV Transformer Control and Relay Panel**				
2.91	Differential relay	1	No		**0.00**
2.92	Master Trip relay	1	No		**0.00**
2.93	Trip Circuit Supervision relay	1	No		**0.00**
2.94	**Testing Kit for Transformers**				
2.95	Automatic Transformer Oil BDV Testing Kit	1	No		**0.00**
2.96	Stainless Steel Oil sampling bottle (One Litre Capacity)	2	No		**0.00**
2.97	Syringes for sampling oil (50ml capacity)	4	No		**0.00**
3.00	**Supply of 33kV Equipments and Panels (Supply C)**				
3.01	33kV,3 Phase, 13 Unit Panel (8 Line Bays, 2 Transformer incomer Bays, 1 Bus Sectionalizer Bay and 2 PT Bay) Indoor Drawn out type switchgear as per specification (Single bus with sectionalizer)	1	Set		**0.00**
3.02	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Pipe Structure, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	24	No		**0.00**

3.03	Outdoor type 36 kV, 1250 A, 3-Ph gang operated, Double Break centre Post rotating outdoor type motor operated Disconnector (Isolator) with solid core Post Insulator, Pipe Structures, Clamps and Connectors				
3.04	With one earth switch	8	Sets		**0.00**
3.05	**Supply of 33kV XLPE Cable and Termination Kit**				
3.06	300 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories	900	Mtr		**0.00**
3.07	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories and related structure for outdoor type.	16	Set		**0.00**
3.08	33kV Support Structure for Outdoor Cable Termination Kit	8	Nos		**0.00**
3.09	**LT Power Cable (1.1kV grade)**				
3.10	(i) 2C, 6 mm2	400	Mtr		**0.00**
3.11	(ii) 4C, 16 mm2	400	Mtr		**0.00**
3.12	(iii) 3½ C, 35 mm2	400	Mtr		**0.00**
3.13	(iv) 3½ C, 70 mm2	400	Mtr		**0.00**
3.14	(v) 3½ C, 300 mm2	400	Mtr		**0.00**
3.15	**LT Control Cable**				
3.16	(i) 4C, 2.5 mm2	250	Mtr		**0.00**
3.17	(ii) 7C, 1.5 mm2	250	Mtr		**0.00**
3.18	(iii) 12C, 1.5 mm2	250	Mtr		**0.00**
3.19	(iv) 19C, 1.5 mm2	250	Mtr		**0.00**
3.20	**Supply of Indoor floor mounted, SIMPLEX type control and relay panels, with mimic & annunciation panel with SAMAST Compliant ABT Meters for 33kV system as per specification**				
3.21	**33 kV Panels**				
3.22	33KV Line Protection & Control Panel with LBB	8	Nos		**0.00**

3.23	33KV Transformer I/C Protection & Control Panel on 33 k V side of Power Transformer	2	Nos		0.00
3.24	33KV Protection & Control Panel for Bus Section	1	Nos		0.00
3.25	**Substation Automation System and Integration with existing SAS**				
3.26	Complete Sub Station Automation System for 132/33kV GSS including Hardware and Software for the substation and remote control stations alongwith associated equipments for the 33kV Line Bays, Transformer Bays, Bus Sectionaliser Bays, Bus PT etc. including integration of existing SAS	11	Nos		0.00
3.27	**Conductor**				
3.28	ACSR Panther	0.3	Km		0.00
3.29	**Bay Steel Structures except equipment mounting structures**				
3.30	**COLUMNS**				
3.31	Column Type 'C5'	3	Nos		0.00
3.32	Column Type 'C6'	6	Nos		0.00
3.33	**BEAMS**				
3.34	Beam Type 'B5'	8	Nos		0.00
3.35	**Insulator and hardwares**				
3.36	33 kV, 90kN Tension String insulators and hardwares suitable for Single Panther conductors	25	Sets		0.00
3.37	33 kV, 70kN Suspension String insulators and hardwares suitable for Single Panther conductors	25	Sets		0.00
3.38	**Illumination System**				
3.39	Indoor Illumination system for the 33kV Indoor Switchgear Room	1	LS		0.00
3.40	**Lightning protection (lightning masts, lightning spikes, shield wires, down conductors etc.)**	1	LS		0.00
Total in Figures					0.00

ANNEXURE–II

SCHEDULE OF QUANTITY (F&I) (SUBSTATION)

(Note: Items and Sub items shown in this Annexure shall only be used in preparing Price Bidding Schedules. Any other items not specifically mentioned here under are Deemed to be included in other Items)

Sl. No.	Item Description	Quantity	Units	Unit ExWorks (exclusive of taxes) In Figures To be entered by the Bidder in Rs. P	TOTAL AMOUNT (Without Taxes) in Rs. P
1	2	4	5	13	53
1	**Supply of 132kV GIS Equipments (F&I A)**				
1.10	145kV,3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed Transformer bay module each set comprising of One (1) number 3-phase, 3150A, SF6 insulated circuit breaker complete with operating mechanism; Three (3) numbers 1-phase, 5-core, multi ratio,600-300/1-1-1-1-1A current transformers; Three (3) numbers 3-phase, 3150A, group operated isolators/disconnectors, complete with manual and motor driven operating mechanisms; One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms; Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required; Local Bay control cubicle.(Stand Alone or Integrated)	2	Sets		0.00
1.20	Three phases, 3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed bus bar of 145kV, each set comprising of Bus bars enclosures running from the existing Bus bar Module to interconnect each of the Transformer circuit breaker bay modules in Double Bus bar configuration; Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required	2	Sets		0.00

1.30	145kV, 3150A, 40 kA for 4 sec, 3- phase SF6 to air bushings along with termination module & support structure for outdoor connections to connect GIS with 145kV side of Power transformer.	2	Sets		**0.00**
1.40	145kV, 3150A, 40kA for 4 second, 3-Ph encapsulated, SF6 Gas Insulated Bus Duct (GIB) outside GIS hall including Bus Duct support structure and associated accessories along with jointing elements	75	RM		**0.00**
1.50	Erection Hardware for 145kV GIS Termination arrangement for Transformer bay Modules	2	Nos		**0.00**
2.00	**Supply of outdoor bay equipments (F&I B)**				
2.01	**Transformer**				
2.02	50 MVA, 132/33 kV, 3-Ph, YNyn0, Z =12.5 %, ONAN/ONAF with copper wound Power Transformer with OLTC(+5% to -15% in steps of 1.25%) , RTCC panel including all cabling, insulating oil for the transformer plus 10% spare oil, supplied with Bushing mounted NCT on HV & LV side & complete with all fittings and accessories to meet the technical specification including cost of all routine test including loading and unloading at site.The Transformer shall be suitable for 4" Aluminium Tubular Conductor termination on HV and LV side.	2	No		**0.00**
2.03	Online DGA	2	No		**0.00**
2.04	Online Insulating oil drying system	2	Sets		**0.00**
2.05	**Lightning Arrester**				
2.06	120 kV, 10 kA, Metal Oxide type, heavy duty, station class 3, Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		**0.00**

2.07	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		**0.00**
2.08	**Supply of 33kV XLPE Cable and Termination Kit**				
2.09	1000 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories	200	Mtr		**0.00**
2.10	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories.	4	Set		**0.00**
2.11	33kV Support Structure for Outdoor Cable Termination Kit	2	Nos		**0.00**
2.12	**LT Power Cable (1.1kV grade)**				
2.13	(i) 2C, 6 mm2	400	Mtr		**0.00**
2.14	(ii) 4C, 16 mm2	400	Mtr		**0.00**
2.15	(iii) 3½ C, 35 mm2	400	Mtr		**0.00**
2.16	(iv) 3½ C, 70 mm2	400	Mtr		**0.00**
2.17	(v) 3½ C, 300 mm2	400	Mtr		**0.00**
2.18	(vi) Cable Supports and fittings	1	LS		**0.00**
2.19	**LT Control Cable**				
2.20	(i) 4C, 2.5 mm2	250	Mtr		**0.00**
2.21	(ii) 7C, 1.5 mm2	250	Mtr		**0.00**
2.22	(iii) 12C, 1.5 mm2	250	Mtr		**0.00**
2.23	(iv) 19C, 1.5 mm2	250	Mtr		**0.00**
2.24	**Earthing**				
2.25	Main Earthing Conductor 40mm dia MS Rod	600	meter		**0.00**
2.26	Earthing Conductor: 40mm dia MS Rod For Riser From The Burial Earth Mat To Equipment,Structure Etc)	600	meter		**0.00**

2.27	Earthing Conductor: 75X12mm GI Flat for Equipment and Structure Earthing	300	meter		**0.00**
2.28	Earthing Conductor: 50X6 mm GI(HDG) Flat For Riser For Console Box,Lt Panels,Dc Panels,Marshalling Boxes, Cable Trenches Etc)	150	meter		**0.00**
2.29	Earthing Device & Associated Accessories (50 mm Heavy Duty GI Perforated Pipe 3 Mtrs Long For Treated Earth Pit)	6	Nos.		**0.00**
2.30	Earthing Device & Associated Accessories 40 mm Ms Rod 3 Mtrs Long For Non Treated Earth Pit)	60	Nos.		**0.00**
2.31	Separate Earthing For 145 Kv GIS Modules	1	JOB		**0.00**
2.32	Separate Earthing For 145 Kv GIS Building	1	JOB		**0.00**
2.33	Separate Earthing For 36 Kv Indoor AIS Equipment	1	JOB		**0.00**
2.34	Separate Earthing For 36 Kv Indoor AIS Building	1	JOB		**0.00**
2.35	Other Earthing Accessories	1	Lot		**0.00**
2.36	**Fire Protection System for Transformer**				
2.37	**NIFPS**				
2.38	N2 Fire Prevention and extinguishing System for transformer with complete accessories and related Civil and Electrical works.	2	No		**0.00**
2.39	**HVWS**				
2.40	HVW spray system, Hydrant System and complete U/G and O/G Piping and accessories etc and associated Civil Works for fire protection system for 2 nos 50 MVA 132/33kV Transformer	1	Set		**0.00**
2.41	HVWS System for 50 MVA ICT	2	Set		**0.00**
2.42	**Portable/Wheel/ Trolley mounted Fire Extinguishers**				
2.43	22.5 Kg capacity FE CO2 type, Trolley Mounted	4	Nos		**0.00**
2.44	25 Kg Capacity FE DCP type, Trolley Mounted	4	Nos		**0.00**
2.45	DCP 10 Kg Capacity, Wall mounted	6	Nos		**0.00**

2.46	FE CO2 6.5 Kg capacity, Wall mounted	4	Nos		**0.00**
2.47	DCP 5 Kg Capacity, Wall mounted	5	Nos		**0.00**
2.48	Foam Type 9-liter Capacity, Wall mounted	4	Nos		**0.00**
2.49	Water CO2 9-liter, Wall mounted	6	Nos		**0.00**
2.50	Fire Buckets (12 Nos. with stand in one set)	1	Set		**0.00**
2.51	**Supply of Indoor floor mounted, SIMPLEX type Control and Relay Panels, with mimic & annunciation panel for 132kV system as per specification comprising of the C & R Panels and shall be complete with Numerical Relays and SAMAST Compliant ABT Meters as per the Technical specifications & shall be compatible for SCADA/ SAS .**				
2.52	**132kV Panels**				
2.53	Transformer Protection Panel	2	No		**0.00**
2.54	**Substation Automation System**				
2.55	Complete Sub Station Automation System for 132/33kV GSS Transformer Bays including Hardware and Software for the substation and remote-control stations alongwith associated equipments for the transformer bay	2	Nos		**0.00**
2.56	Integration with the existing SAS system	1	LS		**0.00**
2.57	**Conductor / IPS Al Tube**				
2.58	4" IPS Al Tube	80	Mtr		**0.00**
2.59	**Lightning protection**				
2.60	Lightning Mast (LM)- 40m	1	No		**0.00**
2.61	**Illumination system for Outdoor Lighting (Switchyard and Street lighting)**				
2.62	Lighting Panel				
2.63	Lighting Panel Type ACP-2	1	Nos		**0.00**
2.64	Sub lighting panel type SLP	2	Nos		**0.00**

2.65	lighting Fixtures and Receptacles including junction box, lighting wires and flexible conduit (if required) from junction box to lighting fixture, mounting arrangement and other accessories/ materials etc as required for complete installation and commissioning of lighting fixture				
2.66	Lighting Fixture Type SF1	4	Nos		0.00
2.67	Lighting Fixture Type SF2	2	Nos		0.00
2.68	Lighting Fixture Type SF4	2	Nos		0.00
2.69	Mandatory Spare Parts				
2.70	**For 132/33KV,50MVA Transformers**				
2.71	145kV H.V. Bushing with metal parts and Gaskets	2	No		0.00
2.72	HV side neutral bushing	2	No		0.00
2.73	36KV LV bushing	2	No		0.00
2.74	36kV Neutral Bushing with metal parts and gaskets	2	No		0.00
2.75	Local and remote winding temperature indicators with alarm and trip contacts and maximum reading pointer	2	Set		0.00
2.76	Oil temperature indictor with alarm and trip contacts and maximum reading pointer	2	Set		0.00
2.77	Pressure relief device for main tank	4	Set		0.00
2.78	Pressure relief device for OLTC	4	Set		0.00
2.79	Silica Gel/ Maintenance free breather assembly (one of each type) for Conservator and OLTC	2	Set		0.00
2.80	Magnetic oil level gauge with low oil level alarm contacts	2	Set		0.00
2.81	Oil Flow indicator with contacts	2	Set		0.00
2.82	Coller Pump with Motor	2	Set		0.00
2.83	Cooler fan with motor.	4	No		0.00
2.84	Buchholz relay.	4	No		0.00
2.85	Tap position Indicator (Local and remote)	2	No		0.00

2.86	Oil Sampling Bottle	4	No		**0.00**
2.87	Oil Surge Relay	4	No		**0.00**
2.88	Complete set of gasket (complete set for one transformer)	2	Set		**0.00**
2.89	Set of valves (complete set for one transformer)	2	Set		**0.00**
2.90	**For 132KV Transformer Control and Relay Panel**				
2.91	Differential relay	1	No		**0.00**
2.92	Master Trip relay	1	No		**0.00**
2.93	Trip Circuit Supervision relay	1	No		**0.00**
2.94	**Testing Kit for Transformers**				
2.95	Automatic Transformer Oil BDV Testing Kit	1	No		**0.00**
2.96	Stainless Steel Oil sampling bottle (One Litre Capacity)	4	No		**0.00**
2.97	Syringes for sampling oil (50ml capacity)	4	No		**0.00**
3.00	**Supply of 33kV Equipments and Panels (F&I C)**				
3.01	33kV,3 Phase, 13 Unit Panel (8 Line Bays, 2 Transformer incomer Bays, 1 Bus Sectionalizer Bay and 2 PT Bay) Indoor Drawn out type switchgear as per specification (Single bus with sectionalizer)	1	Set		**0.00**
3.02	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Pipe Structure, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	24	No		**0.00**
3.03	Outdoor type 36 kV, 1250 A, 3-Ph gang operated, Double Break centre Post rotating outdoor type motor operated Disconnector (Isolator) with solid core Post Insulator, Pipe Structures, Clamps and Connectors				
3.04	With one earth switch	8	Sets		**0.00**
3.05	**Supply of 33kV XLPE Cable and Termination Kit**				
3.06	300 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories	900	Mtr		**0.00**

3.07	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories and related structure for outdoor type.	16	Set		**0.00**
3.08	33kV Support Structure for Outdoor Cable Termination Kit	8	Nos		**0.00**
3.09	**LT Power Cable (1.1kV grade)**				
3.10	(i) 2C, 6 mm2	400	Mtr		**0.00**
3.11	(ii) 4C, 16 mm2	400	Mtr		**0.00**
3.12	(iii) 3½ C, 35 mm2	400	Mtr		**0.00**
3.13	(iv) 3½ C, 70 mm2	400	Mtr		**0.00**
3.14	(v) 3½ C, 300 mm2	400	Mtr		**0.00**
3.15	**LT Control Cable**				
3.16	(i) 4C, 2.5 mm2	250	Mtr		**0.00**
3.17	(ii) 7C, 1.5 mm2	250	Mtr		**0.00**
3.18	(iii) 12C, 1.5 mm2	250	Mtr		**0.00**
3.19	(iv) 19C, 1.5 mm2	250	Mtr		**0.00**
3.20	**Supply of Indoor floor mounted, SIMPLEX type control and relay panels, with mimic & annunciation panel with SAMAST Compliant ABT Meters for 33kV system as per specification**				
3.21	**33 kV Panels**				
3.22	33KV Line Protection & Control Panel with LBB	8	Nos		**0.00**
3.23	33KV Transformer I/C Protection & Control Panel on 33 k V side of Power Transformer	2	Nos		**0.00**
3.24	33KV Protection & Control Panel for Bus Section	1	Nos		**0.00**
3.25	**Substation Automation System and Integration with existing SAS**				

3.26	Complete Sub Station Automation System for 132/33kV GSS including Hardware and Software for the substation and remote control stations alongwith associated equipments for the 33kV Line Bays, Transformer Bays, Bus Sectionaliser Bays, Bus PT etc. including integration of existing SAS	11	Nos		**0.00**
3.27	**Conductor**				
3.28	ACSR Panther	0.3	Km		**0.00**
3.29	**Bay Steel Structures except equipment mounting structures**				
3.30	**COLUMNS**				
3.31	Column Type 'C5'	3	Nos		**0.00**
3.32	Column Type 'C6'	6	Nos		**0.00**
3.33	**BEAMS**				
3.34	Beam Type 'B5'	8	Nos		**0.00**
3.35	**Insulator and hardwares**				
3.36	33 kV, 90kN Tension String insulators and hardwares suitable for Single Panther conductors	25	Sets		**0.00**
3.37	33 kV, 70kN Suspension String insulators and hardwares suitable for Single Panther conductors	25	Sets		**0.00**
3.38	**Illumination System**				
3.39	Indoor Illumination system for the 33kV Indoor Switchgear Room	1	LS		**0.00**
3.40	**Lightning protection (lightning masts, lightning spikes, shield wires, down conductors etc.)**	1	LS		**0.00**
Total in Figures					**0.00**

ANNEXURE–III

SCHEDULE OF QUANTITY (ERECTION)(SUB-STATION)

(Note: Items and Sub items shown in this Annexure shall only be used in preparing Price Bidding Schedules. Any other items not specifically mentioned here under are Deemed to be included in other Items)

Sl. No.	Item Description	Quantity	Units	Unit ExWorks (exclusive of taxes) In Figures To be entered by the Bidder in Rs. P	TOTAL AMOUNT (Without Taxes) in Rs. P
1	2	4	5	13	53
1	**Foundation, Erection, Testing & Commissioning of 132kV GIS Equipments (Erection A)**				
1.10	145kV, 3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed Transformer bay module each set comprising of One (1) number 3-phase, 3150A, SF6 insulated circuit breaker complete with operating mechanism; Three (3) numbers 1-phase, 5-core, multi ratio,600-300/1-1-1-1-1A current transformers; Three (3) numbers 3-phase, 3150A, group operated isolators/disconnectors, complete with manual and motor driven operating mechanisms; One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms;Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required; Local Bay control cubicle.(Stand Alone or Integrated)	2	Sets		0.00
1.20	Three phase, 3150A, 40kA for 4 second, SF6 gas-insulated metal enclosed bus bar of 145kV, each set comprising of Bus bars enclosures running from the existing Bus bar Module to interconnect each of the Transformer circuit breaker bay modules in Double Bus bar configuration; Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required	2	Sets		0.00
1.30	145kV, 3150A, 40 kA for 4 sec, 3- phase SF6 to air bushings along with termination module & support structure for outdoor connections to connect GIS with 145kV side of Power transformer.	2	Sets		0.00

1.40	145kV, 3150A, 40kA for 4 second, 3-Ph encapsulated, SF6 Gas Insulated Bus Duct (GIB) outside GIS hall including Bus Duct support structure and associated accessories along with jointing elements	75	RM		**0.00**
1.50	Erection Hardware for 145kV GIS Termination arrangement for Transformer bay Modules	2	Sets		**0.00**
2.00	**Foundation,Erection, Testing & Commissioning of outdoor bay equipments (Erection B)**				
2.01	**Transformer**				
2.02	50 MVA, 132/33 kV, 3-Ph, YNyn0, Z =12.5 %, ONAN/ONAF with copper wound Power Transformer with OLTC(+5% to -15% in steps of 1.25%) , RTCC panel including all cabling, insulating oil for the transformer plus 10% spare oil, supplied with Bushing mounted NCT on HV & LV side & complete with all fittings and accessories to meet the technical specification including cost of all routine test including loading and unloading at site.The Transformer shall be suitable for 4" Aluminium Tubular Conductor termination on HV and LV side.	2	No		**0.00**
2.03	Online DGA	2	No		**0.00**
2.04	Online Insulating oil drying system	2	Sets		**0.00**
2.05	**Lightning Arrester**				
2.06	120 kV, 10 kA, Metal Oxide type, heavy duty, station class 3, Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		**0.00**
2.07	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Pipe Structures, Surge Counter, Hardware fittings and Clamps and Connectors as per specification	6	No		**0.00**

2.08	**Erection of 33kV XLPE Cable and Termination Kit**				
2.09	Laying of 1000 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories in cable trenches and cable terminations including supply of cable end sealing boxes, construction of cable trenches etc	200	Mtr		**0.00**
2.10	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories and related structure for outdoor type.	4	Set		**0.00**
2.11	33kV Support Structure for Outdoor Cable Termination Kit	2	Nos		**0.00**
2.12	**Earthing**				
2.13	Main Earthing Conductor 40mm dia MS Rod	600	meter		**0.00**
2.14	Earthing Conductor: 40mm dia MS Rod For Riser From The Burial Earth Mat To Equipment,Structure Etc)	600	meter		**0.00**
2.15	Earthing Conductor: 75X12mm GI Flat For Equipment and Structure Earthing	300	meter		**0.00**
2.16	Earthing Conductor: 50X6 mm GI(HDG) Flat For Riser For Console Box,Lt Panels,Dc Panels,Marshalling Boxes, Cable Trenches Etc)	150	meter		**0.00**
2.17	Earthing Device & Associated Accessories (50 mm Heavy Duty GI Perforated Pipe 3 Mtrs Long For Treated Earth Pit)	6	Nos.		**0.00**
2.18	Earthing Device & Associated Accessories 40Mm Ms Rod 3 Mtrs Long For Non Treated Earth Pit)	60	Nos.		**0.00**
2.19	Soil Resistivity Test And Soil Treatment As And When Required	1	JOB		**0.00**
2.20	Separate Earthing For 145 Kv GIS Modules	1	JOB		**0.00**
2.21	Separate Earthing For 145 Kv GIS Building	1	JOB		**0.00**
2.22	Separate Earthing For 36 Kv Indoor AIS Equipment	1	JOB		**0.00**
2.23	Separate Earthing For 36 Kv Indoor AIS Building	1	JOB		**0.00**

2.24	Other Earthing Accessories	1	Lot		0.00
2.25	**Fire Protection System for Transformer**				
2.26	**NIFPS**				
2.27	N2 Fire Prevention and extinguishing System for transformer with complete accessories and related Civil and Electrical works.	2	No		0.00
2.28	**HVWS**				
2.29	HVW spray system, Hydrant System and complete U/G and O/G Piping and accessories etc and associated Civil Works for fire protection system for 2 nos 50 MVA 132/33kV Transformer	1	Set		0.00
2.30	HVWS System for 50 MVA ICT	2	Set		0.00
2.31	**Portable/Wheel/ Trolley mounted Fire Extinguishers**				
2.32	22.5 Kg capacity FE CO2 type, Trolley Mounted	4	Nos		0.00
2.33	25 Kg Capacity FE DCP type, Trolley Mounted	4	Nos		0.00
2.34	DCP 10 Kg Capacity, Wall mounted	6	Nos		0.00
2.35	FE CO2 6.5 Kg capacity, Wall mounted	4	Nos		0.00
2.36	DCP 5 Kg Capacity, Wall mounted	5	Nos		0.00
2.37	Foam Type 9 liter Capacity, Wall mounted	4	Nos		0.00
2.38	Water CO2 9 liter, Wall mounted	6	Nos		0.00
2.39	Fire Buckets (12 Nos. with stand in one set)	1	Set		0.00
2.40	**Erection of Indoor floor mounted, SIMPLEX type Control and Relay Panels, with mimic & annunciation panel for 132kV system as per specification comprising of the C & R Panels and shall be complete with Numerical Relays and SAMAST Compliant ABT Meters as per the Technical specifications & shall be compatible for SCADA/ SAS .**				

2.41	**132kV Panels**				
2.42	Transformer Protection Panel	2	No		**0.00**
2.43	**Substation Automation System**				
2.44	Complete Sub Station Automation System for 132/33kV GSS Transformer Bays including Hardware and Software for the substation and remote control stations alongwith associated equipments for the transformer bay	2	Nos		**0.00**
2.45	Integration with the existing SAS system	1	LS		**0.00**
2.46	**Conductor / IPS Al Tube**				
2.47	4" IPS Al Tube	80	Mtr		**0.00**
2.48	**Lightning protection**				
2.49	Lightning Mast (LM)- 40m	1	No		**0.00**
2.50	**Erection of mounting structures as required including construction of foundations and supply of all foundation materials.**				
2.51	**132kV Equipments**				
2.52	Lightning Arrester (1 Phase)	6	Nos		**0.00**
2.53	**33kV Equipments**				
2.54	Lightning Arrester (1 Phase)	6	Nos		**0.00**
2.55	**Illumination system for Outdoor Lighting (Switchyard and Street lighting)**				
2.56	Lighting Panel				
2.57	Lighting Panel Type ACP-2	1	Nos		**0.00**
2.58	Sub lighting panel type SLP	2	Nos		**0.00**

2.59	lighting Fixtures and Receptacles including junction box, lighting wires and flexible conduit (if required) from junction box to lighting fixture, mounting arrangement and other accessories/ materials etc as required for complete installation and commissioning of lighting fixture				
2.60	Lighting Fixture Type SF1	4	Nos		0.00
2.61	Lighting Fixture Type SF2	2	Nos		0.00
2.62	Lighting Fixture Type SF4	2	Nos		0.00
3.00	**Foundation,Erection, Testing & Commissioning of 33kV Equipments and Panels(Erection C)**				
3.01	33kV,3 Phase, 13 Unit Panel (8 Line Bays, 2 Transformer incomer Bays, 1 Bus Sectionalizer Bay and 2 PT Bay) Indoor Drawn out type switchgear as per specification (Single bus with sectionalizer)	1	Set		0.00
3.02	30 kV,10 kA, Metal Oxide type, heavy duty, station class Lightning Arrestor complete with Surge Counter & copper connecting lead	24	No		0.00
3.03	Outdoor type 36 kV, 1250 A, 3-Ph gang operated, outdoor type, Double Break centre Post rotating outdoor type motor operated Disconnector (Isolator) with solid core Post Insulator.				
3.04	With one earth switch	8	Sets		0.00
3.05	**Supply of 33kV XLPE Cable and Termination Kit**				
3.06	300 sqmm, 33kV, 1-Core, XLPE Armoured Cu cable alongwith related accessories	900	Mtr		0.00
3.07	33kV Cable Termination Kit (both indoor and outdoor) along with its accessories and related structure for outdoor type.	16	Set		0.00
3.08	33kV Support Structure for Outdoor Cable Termination Kit	8	Nos		0.00

3.09	**Erection of Control, Relay & Protection Panel(Simplex Type) with mimic & annunciation panel with ABT Meters for 33kV system as per specification**				
3.10	**33 kV Panels**				
3.11	33KV Line Protection & Control Panel	8	Nos		**0.00**
3.12	33KV Transformer I/C Protection & Control Panel on 33 k V side of Power Transformer	2	Nos		**0.00**
3.13	33KV Protection & Control Panel for Bus Section	1	Nos		**0.00**
3.14	**Substation Automation System and Integration with existing SAS**				
3.15	Complete Sub Station Automation System for 132/33kV GSS including Hardware and Software for the substation and remote control stations alongwith associated equipments for the 33kV Line Bays, Transformer Bays, Bus Sectionaliser Bays, Bus PT etc. including integration of existing SAS	11	Nos		**0.00**
3.16	**Bay Steel Structures except equipment mounting structures**				
3.17	**COLUMNS**				
3.18	Column Type 'C5'	3	Nos		**0.00**
3.19	Column Type 'C6'	6	Nos		**0.00**
3.20	Construction of foundations for lattice steel columns including supply of all foundation materials and labour	1	Lot		**0.00**
3.21	**BEAMS**				
3.22	Beam Type 'B5'	8	Nos		**0.00**
3.23	Erection of Foundation Bolts (including nuts, checknut and washers for lattice and pipe structures)	1	Lot		**0.00**
3.24	Erection of Fasteners (nuts, bolts and washers) including step bolts for lattice and pipe structures	1	Lot		**0.00**

3.25	**Erection of mounting structures as required for Lightning Arrester including construction of foundations and supply of all foundation materials.**				
3.26	**33kV Equipments**				
3.27	Isolator	8	Sets		0.00
3.28	Lightning Arrester (1 Phase)	24	Nos		0.00
3.29	**Illumination System**				
3.30	Indoor Illumination system for the 33kV Indoor Switchgear Room	1	LS		0.00
3.31	**Lightning protection (lightning masts, lightning spikes, shield wires, down conductors etc.)**	1	LS		0.00
Total in Figures					0.00

ANNEXURE–IV

SCHEDULE OF QUANTITY (Civil Works)

(Note: Items and Sub items shown in this Annexure shall only be used in preparing Price Bidding Schedules. Any other items not specifically mentioned here under are Deemed to be included in other Items)

Sl. No.	Item Description	Quantity	Units	Unit ExWorks (exclusive of taxes) In Figures To be entered by the Bidder in Rs. P	TOTAL AMOUNT (Without Taxes) in Rs. P
1	2	4	5	13	53
1	**Site development, PCC and Gravelling work**				
1.01	**Surface dressing** of ground including removing vegetation and/ or undulation of ground not exceeding 150mm deep and disposal of rubbish outside the periphery and lift up to 1800mm in all kinds of soil.	4000.00	Sqm		0.00

1.02	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. (A) Up to a depth of 2.00m below the existing ground level. (a) In ordinary soil.	5000.00	cum		**0.00**
1.03	**Raising low site** around the building with approved soil obtained from outside by truck carriage including breaking clods, dressing etc. complete including paying necessary forest royelty, sales tax, land compensation, municipal gate fees, if any monopoly duty etc. complete as directed and specified. (Measurement will be taken after compaction of the soil and actual compacted volumn only)	3500.00	Cum		**0.00**
1.04	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete. (b) In prop 1cement: 3 sands :6 coarse aggregate by volume	350.00	Cum		**0.00**
1.05	Supplying fixing PVC pipes of 6 kg/m2 9Supreme/Prince) or other I.S.I approved……. (a) In exposed or in trenches. (ii) 110 mm dia..	225.00	RM		**0.00**
1.06	Providing fiting&fixing C.I. Grating to the floors complete as directed and specified. (a) 110mm dia	750	Each		**0.00**
1.07	Supplying and laying 100 mm thick machine crushed 20 mm stone aggregates in layers including cost of haulage, loading, unloading, cleaning, spreading complete as directed.	350	Cum		**0.00**

1.08	**Trenches work**				
1.09	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. (A) Up to a depth of 2.00m below the existing ground level. (a) In ordinary soil.	56.25	Cum		**0.00**
1.10	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1cement: 3 sand :6 coarse aggregate by volume	7.03	Cum		**0.00**
1.11	RCC Work with12 mm thick Plywood Shuttering Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately) Using mixture machine In sub - structure up to plinth level Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level.Without using admixture, plasticiser M25 grade concrete	45.54	Cum		**0.00**

1.12	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code forR.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reiforcement bar.	212.65	Qtl		**0.00**
1.13	Structure Steel Structural steel work in sigle sections including cutting, hoisting, fixing in position and applying a priming coat of red lead paint (up to 4.6m height) from plinth level including drilling holes, supplying, fitting and fixing with bolts and nuts or welding, if necessary as directed. c) In M.S. angles, channels, Tees etc.	12.00	Qtl		**0.00**
1.14	Supplying fitting and fixing of perforated GI cable tray of size (300 mm x 50 mm) and thickness 1.5 mm	50.00	Rm		**0.00**
1.15	Providing and fixing on wall face unplasticised rigid pvc rain water pipes conforming to IS 13592 type a including jointing with seal ring conforming to IS 5382 leaving 10mm gap for thermal expansion. (i) single socketed pipes 110mm diameter	100.00	Rm		**0.00**
1.16	**Boundary/Retaining wall**				

1.17	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. (A) Up to a depth of 2.00m below the existing ground level. (a) In ordinary soil.	924.00	cum		**0.00**
1.18	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1cement: 3 sand :6 coarse aggregate by volume	30.80	cum		**0.00**
1.19	**RCC Work with 12mm thick Plywood Shuttering Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately)**				
1.20	In substructure up to plinth level ;- Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level. Without using admixture, plasticiser M20 grade concrete	93.10	cum		**0.00**

1.21	In super structure from plinth level up to 1st floor level. Columns, pillars, posts, struts, suspended floor, roof, landing, shelf and support, balcony, lintel, sill band, beam, girder, bressumer, cantilever, staircase (except spiral staircase and landing) including preparing the top surface and finishing of nosing. Without using admixture, plasticiser M20 grade concrete	28.57	cum		**0.00**
1.22	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code forR.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reiforcement bar.	16.424	Qtl		**0.00**
1.23	Stone masonary work in retaining wall, wing wall, abutment, foundation, steps, plinth etc. in cement mortar in prop 1:6 with levelling course of 1:6:12 with both faces hammer dressed including bonding, providing face stone, through stone and centering including racking of joints, curing and supplying and all carriage of stone as directed including payment of forest royalty and sales tax and carriage. (b) Coarse Rubble Masonry	980	cum		**0.00**
1.24	**Tower foundations**				

1.25	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. In all type of soil and strata.	159.08	cum		**0.00**
1.26	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code for R.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reiforcement bar.	111.35	Qtl		**0.00**
1.27	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1 cement: 3 sand :6 coarse aggregate by volume	7.58	cum		**0.00**

1.28	**RCC Work with 12mm thick Plywood Shuttering Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately) Using mixture machine**				
1.29	In sub - structure up to plinth level : Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level. Without using admixture, plasticiser M20 grade concrete	58.54	cum		**0.00**
1.30	**Equipment foundations**				
1.31	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. In all type of soil and strata.	510.68	cum		**0.00**
1.32	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1 cement: 3 sand :6 coarse aggregate by volume	23.17	cum		**0.00**

1.33	RCC Work with12 mm thick Plywood Shuttering: Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately) Using mixture machine In sub - structure up to plinth level Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level. Without using admixture, plasticiser M20 grade concrete	149.48	cum		**0.00**
1.34	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code for R.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reiforcement bar.	123.33	Qtl		**0.00**
1.35	**50 MVA Power Transformer foundation-2 Nos**				

1.36	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. In all type of soil and strata.	313.96	cum		**0.00**
1.37	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1 cement: 3 sand :6 coarse aggregate by volume	20.96	cum		**0.00**
1.38	RCC Work with 12mm thick Plywood Shuttering: Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately) Using mixture machine In sub - structure up to plinth level Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level.Without using admixture, plasticiser M20 grade concrete	53.25	cum		**0.00**

1.39	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code for R.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reiforcement bar.	63.90	Qtl		**0.00**
1.40	Structure Steel Structural steel work in sigle sections including cutting, hoisting, fixing in position and applying a priming coat of red lead paint (up to 4.6m height) from plinth level including drilling holes, supplying, fitting and fixing with bolts and nuts or welding, if necessary as directed. c) In M.S. angles, channels, Tees etc.	183.84	Qtl		**0.00**
1.41	**Fire Protection wall- 1 Nos**				
1.42	Earthwork in excavation for foundation trenches of walls, retaining walls, footings of column, steps, septic tank etc. including refilling (return filling) the quantity as necessary after completion of work, breaking clods in return filling, dressing, watering and ramming etc. and removal of surplus earth with all lead and lifts as directed and specified in the following classification of soils including bailing out water where necessary as directed and specified. In all type of soil and strata.	59.36	cum		**0.00**

1.43	Plain cement concrete works with coarse aggregate of sizes 13mm to 32mm in foundation bed for footing steps, walls, brick works etc. as directed and specified including dewatering if necessary, and curing complete (shuttering where necessary shall be measured and paid separately). (b) In prop 1cement: 3 sand :6 coarse aggregate by volume	1.54	cum		**0.00**
1.44	Providing soling in foundation and under floor with stone/ best quality picked jhama brick, sand packed and laid to level and in panel after preparing the subgrade as directed including all labour and materials and if necessary dewatering, complete.(a).Brick on flat soling.	22.19	cum		**0.00**
1.45	**RCC Work with 12mm thick Plywood Shuttering Providing and laying plain/reinforced cement croncrete works using cement, coarse sand & 20mm down graded stone aggregate with cost of necessary form work including dewatering if necessary, and curing for reinforced cement concrete work complete as directed (Reinforcement will be measured and paid separately)**				
1.46	In substructure up to plinth level ;- Foundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level. Without using admixture, plasticiser M20 grade concrete	8.81	cum		**0.00**
1.47	In super structure from plinth level up to 1st floor level. Columns, pillars, posts, struts, suspended floor, roof, landing, shelf and support, balcony, lintel, sill band, beam, girder, bressumer, cantilever, staircase (except spiral staircase and landing) including preparing the top surface and finishing of nosing. Without using admixture, plasticiser M20 grade concrete	3.66	cum		**0.00**

1.48	Supplying, fitting and fixing in position reinforcement bars conforming to relevant I.S. Code forR.C.C. work/ R.B. walling including straightening, cleaning, cutting and bending to proper shapes and length as per details, supplying and binding with 20G annealed black wire and placing in position with proper blocks, supports, chairs, spacers etc. complete. (No extra measurement for lap, hook, chair, anchor etc. will be entertained in the measurement as they are included in the rate) (Upto 1st floor level) (a) From Primary Producer: TATA/SAIL/Esser Steel/ Jindal steel/Shyam steel/RINL (i) TMT Corrosion resistant steel (CRS) reinforcement bar..	9.290	Qtl		**0.00**
1.49	Brick work in cement morter with 1st class brick including racking out joints and curing complete as directed. (II) In superstructure above plinth level up to 1st floor level. (c) In proportion 1:4.(1 cement:4 sand)	29.07	cum		**0.00**
1.50	External Plaster work with water proofing materials ; - 20 mm thick Cement plaster in two coats on single or half brick walls for interior plastering up to 1st floor level including arises, internal rounded angles,chamfers and / or rounded angles not exceeding 80mm in girth and finished even and smooth including curing complete as directed. B. On fair side (backing coat 10 mm and finishing coat 10mm thick) (b) In cement mortar 1:4.	148.29	Sqm.		**0.00**
1.51	Applying two coats of primer of approved brand and manufacture on new wall surface after throughly brooming the surfaces free from mortar droppings and other foreign matter and including preparing the surface even and sand papered smooth.	148.29	Sqm.		**0.00**

1.52	Finishing wall with external weather coat paint of approved brand and manufacture and of required shade on new wall surface (two coats) to give an even shade after throughly brooming the surfaces to remove all dirt and remains of loose powdered materials.	148.29	Sqm.		**0.00**
1.53	**VCB Building**				
1.54	Design and Construction of VCB Building (H=6.00 meter, L=25.0m, B=7.0m) with all finishes, Sanitary System,Plumbing,Electrification, fire fighting etc as per the drawing ,specification and direction of Engineer In Charge .Rate shall include supply of all material, labour and other cost to complete the Job.	175.00	SqMeter		**0.00**
1.55	**PCC Road**				
1.56	Providing brick soling in foundation and under floor with stone/ best quality picked jhama brick, sand packed and laid to level and in panel after preparing the subgrade as directed including all labour and materials and if necessary dewatering, complete.	750.00	Sqm		**0.00**
1.57	Providing and laying plain/reinforced cement croncrete works cement, coarse sand & 20mm down graded stone aggregate including dewatering if necessary, and curing complete but excluding cost of form work and reinforcement for reinforced cement concrete work (form work and reinforcement will be measured and paid separately) (I) Using Mixer Machine(A) In substructure up to plinth levelFoundation, footing, columns with base tie and plinth beam, pile cap, base slab, retaining walls, walls of septic tank, inspection pit and the like and other works not less than 100mm thick up to plinth level.N) Without using admixture, plasticisera) M20 grade concrete or Prop. 1:1.5:3	112.50	Cum		**0.00**
1.58	RCC Storm water drain of size 350 mm width and 300 mm depth (internal) including cost of earth excavation, shuttering, Brick soling, PCC, reinforcement, concrete (1:1.5:3) plastering, labour cost, etc. complete as per approved drawing and directed including all other cost to complete the job	120.00	Rm		**0.00**
Total in Figures					**0.00**

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 set 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, 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 The drawings supplied for Control Room building are mainly related to structural part of the building. These drawings also include few minimum requirements inside the CRB. The Contractor will be required to design and develop drawings for other facilities inside the CRB, such as illumination system, air conditioning system etc. as per Specification and will submit those for approval of the Employer.

2.1.6 Only single line 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 SITE PREPARATION

2.2.1 The Contractor shall be responsible for proper levelling of switchyard site as per layout and levels of switchyard finalised during detailed engineering stage. The Contractor at his own cost shall make the layout and levels of all structure, etc., from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. Marking B.M. pillars and reference line pillars etc. and maintaining them up to the completion of the work shall be the responsibility of the Contractor.

2.2.2 Site levelling shall be in the scope of the Contractor. The finished ground level (FGL) of the switchyard area shall have to be fixed 300 mm above the highest flood level (HFL) of that area or site. After proper survey the Contractor have to prepare a Contour Map showing the existing levels of that area in respect of the B.M. and shall have to submit the same to the Employer for scrutiny and approval. Construction of general grid, B.M, HFL pillars etc is the responsibility of the Contractor. The Contractor shall give all help in instruments, materials and personal to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

2.2.3 As per contour of the switchyard site, the Contractor shall have to prepare the site by earth cutting or filling as per site condition to arrive at the required F.G.L. Site preparation of the switchyard area shall be done ***extending 5.00 meter all around the security fencing***.

2.3.0 SURFACE PREPARATION AND STONE SPREADING

2.3.1 Apart from anti-weed measures, stone spreading shall be done in the area covered by the earth mat including area extending one (1) meter all around the earthmat provided for switchyard

2.3.2 Before taking up PCC base (prop 1:3:6) and stone filling, the area shall be thoroughly de-weeded including removal of roots.

2.3.3 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.

2.3.4 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 CP gratings at the top and the same will be flushed with the PCC top.

2.3.5 Over the PCC layer, a surface course of minimum 100 mm thickness of 20 mm nominal size Crushed stone shall be spread.

2.4.0 SITE DRAINAGE

2.4.1 Adequate site drainage system shall be prepared by the Contractor. However, this drawing shall be submitted by contractor.

2.4.2 Another drawing of drains and other features are also supplied with this bidding document. The Contractor shall prepare the drainage system based on this drawing.

2.4.3 The Contractor shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts, etc., to prevent erosion of material by water.

2.4.4 Invert of the drainage system shall be decided in such a way that the water can easily be discharged above the High Flood Level (HFL) outside substation boundary at suitable location up to a maximum 50 M beyond boundary wall of substation or actual whichever occurs earlier and approved by Employer. Pumps for drainage of water (if required) shall be provided by Contractor.

2.4.5 All internal site drainage system, including the final connection/disposal to Employer acceptance points shall be part of Supplier's scope including all required civil work, mechanical and electrical systems. The Contractor shall connect his drain(s) at one or more points to outfall points as feasible at site.

2.4.6 The drainage scheme and associated drawings shall be got approved.

2.5.0 ROADS, PAVEMENTS AND CULVERTS

2.5.1 The roads for access to equipment and building including pavements within substation are in the scope of bidder. Layout of the roads shall be based on General detail and Arrangement drawing for the substation.

2.5.2 All substation roads and pavements shall be constructed to permit transportation of all heavy equipment. The roads shall have black topping as per technical specification. Moorum shoulder shall be provided on either side of the road. The width of the shoulder shall be as per approved drawing depending upon the site conditions.

2.5.3 Road construction shall be as per IRC (Indian Road Congress) standards.

2.5.4 Adequate provision shall be made for road drainage. Protection of cut and embankment slopes of roads as per slope stability requirement shall be made.

2.5.5 All the culverts and its allied structure (required for road/rail, drain trench crossings, etc.) shall be designed for Class-AA loading as per IRC standard/IS code and should be checked for loading.

2.5.6 All roads shall be designed for Class-`E' of traffic as per IRC-37 Guidelines for the design of flexible pavements.

2.6.0 TRANSFORMER FOUNDATION AND OIL RECOVERY SYSTEM

2.6.1 The Contractor shall provide an oil recovery system for all power transformers containing insulating oil, integrated with the transformer foundations.

2.6.2 The oil recovery system ***shall be constructed as per approved drawings submitted by the contractor.***

2.6.3 The minimum height of the retaining walls shall be 30 cm above the finished level of the ground to avoid outside water pouring inside.

The bottom of the pit shall have a uniform slope towards the sump pit.

2.6.4 **Drainage**

A device showing level of sump pit shall be provided by Contractor fitted along with the automatic/manual pumping system, which shall have sufficient capacity to evacuate the rainwater from the sump pit. The Contractor may propose another better scheme, if agreed by Employer.

2.6.5 Transformers shall be mounted on a rail fitted on top of the foundation for its easy removal from foundation/oil collection pit.

2.7.0 CABLE TRENCHES AND CABLE TRAYS

2.7.1 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.

2.7.2 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 2000 mm.

2.7.3 If asked for, the cable trench walls shall be designed for following loads:

(a) Dead load of 155 kg/M length of cable support (tray) + 75 kg on one tier at the end.

(b) Triangular earth pressure + uniform surcharge pressure of 2T/m2.

2.7.4 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.

2.7.5 Cable trench inside the Control Room shall be covered with 6 mm thick chequered plates with lifting arrangement and rubber mat.

2.7.6 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.

2.7.7 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.

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

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

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

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

2.7.12 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.

2.7.13 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.

2.7.14 **Cable Trays**

(i). The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2 mm.

(ii). The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.

b) Deflection Test: (Type Test)

A 2.5 metre straight section of 300mm, wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

2.8.0 FOUNDATION AND RCC CONSTRUCTION

2.8.1 General

2.8.1.1. 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. **For design of foundations, bidders shall refer to the Soil Investigation Report uploaded alongwith the Bidding Document.**

2.8.1.2. 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 and M25 for pile foundation as per latest IS 456.

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

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

2.8.1.5. 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.

2.8.1.6. 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.

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

2.8.1.8. 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 fro 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.

2.8.2 **Design**

2.8.2.1. 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.

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

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

2.8.2.4. 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.

2.8.2.5. 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.

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

2.8.2.7. 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.

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

2.8.2.9. 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.

2.8.2.10. 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.

2.8.2.11. 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.

2.8.2.12. 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 surchargepressure 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 waterpressure 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.

2.8.2.13 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.

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

2.8.2.15. 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 pullout. The same factors shall be used as partial safety factor overloads in limit state design also.

2.8.3 **Admixtures & Additives**

2.8.3.1. 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.

2.8.3.2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall

conform to IS: 2645. Employer shall approve concrete Admixtures/Additives.

2.8.3.3. 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.

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

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

2.9.0 **CONTROL ROOM BUILDING**

2.9.1 **General**

The scope includes the detail engineering and construction including anti-termite treatment, plinth protection, DPC of Building including sanitary, water supply, electrification, false ceiling etc., of control room building.

33 kV VCB Building

Structural part of the VCB Building shall be prepared by contractor and approved by employer.
Dimention of building (H=6.0 m, B=7.0m and L=25.0 m)

The roof shall be slope roof and proper water proofing treatment with adequate slope shall be provided for preventing accumulation of rain water.

The finished plinth level of the Control Room Building shall be 600 mm high from the finished ground level.

Plinth Wall and Plinth Filling

The plinth wall shall be of 230 mm thick brick/stone masonry works in cement mortar prop. 1:3 over tie beams or as per approved design with cement plaster prop.1:4 on exposed faces with neat cement finishes.

Plinth filling of the control room building shall have to be done by river sand in layers not exceeding 150 mm at a time with proper compacting.

2.9.4 **Damp Proof Course (DPC)**

2.9.4.1. A 40 mm thick DPC shall be provided with cement concrete in prop.1:1.5:3 with grade stone aggregate of 10 mm down nominal size including providing approved damp proof admixture. Water proof cement additive shall conform to IS 2645.

2.9.5 **Brick Work**

2.9.5.1. Control room building shall be framed superstructure. All walls shall be non-load bearing wall.
All walls shall be 230 mm thick with first class brick with cement mortar in prop.1:4.

2.9.6 **Roof and Parapet Wall**

2.9.6.1. Minimum thickness of the roof slab shall not be less than 125 mm. roof slab shall be extended 600 mm from building. Parapet wall shall be at the edge of roof slab. RCC porch above the rolling shutter & ramp. 500 mm chajja above the windows.

2.9.6.2. A 750 mm high 112 mm thick parapet wall with first class brick and 1:4 cement mortar parapet wall shall be provided all around roof slab with mullion @ 2.5 m c/c spacing. The parapet wall shall be provided with a full brick top lining.

2.9.7 **Roof Treatment**

Roof of control room building shall consist of cast-in-situ R.C.C slab with a water proofing system which shall be an integral cement base treatment and shall be of following operations:

Surface Preparation: - Cleaning the roof slab and parapet wall absolutely free from dust, foreign materials etc.

(a) Chemical Treatment: - Application of two coats of RoffHyguard Ex or equivalant. To be coated by brush on the entire roof area (mother slab) and up to the height of parapet wall.

(b) The junction between the slab and parapet wall is the weakest point resulting into passage of water from the roof down the wall line. To make this area fully water proof, a'V' groove (20 mm wide and 10 mm deep, approx.) shall be made and shall be filled with either polymer modified mortar in GOLA shape of average thickness of 50 mm or with sealant (Roof joint seal P.G.G).

(c) On the top of the Hyguard Ex. Treatment surface, cement concrete (1:2:4) with graded stone aggregate of 12 mm down nominal size with admixture RoffHyproof conforming to IS 2645 shall be provided to an average thickness of 25 mm with slope towards the drainage points. Parapet walls shall be covered by 15 mm thick cement plaster in prop. 1:4 with admixture RoffHyproof. Cement concreting shall be done by paneling 5 M X 5 M and panel joints shall be sealed with multi-seal G.P as per requirement of the Employer.

2.9.8 **Rain Water Pipe**

110 MM dia cast iron/PVC pipes (minimum 6 kg pressure as per IS) with necessary fittings shall be provided.

2.9.9 **Apron Drain**

2.9.9.1. PCC apron in prop. 1:1.5:3 of thickness 100 mm and width 600 mm over a flat brick soling including neat cement finishes all around the Control Room Building (except cable trench portion) shall be provided.

2.9.9.2. 300 mm wide Cement Concrete apron drain shall be provided with CC prop. 1:1.5:3, 100 mm thick sides and 100 mm thick bed over a flat brick soling including 15 mm thick cement plastering in proportion 1:3 and finished with neat cement. The depth of the drain shall be 150 mm at start and sloping uniformly at 1 in 500 towards outlet.

2.9.10 **Plastering**

2.9.10.1. All interior walls shall have minimum 15 mm thick plaster with 1:4 cement sand mortar. The ceiling shall have 10 mm thick 1:4 cement sand mortar.

2.9.10.2. All external wall surfaces shall have 20 mm thick plaster in two coats. The first layer shall be of 15 mm thick 1:4 cement plaster and finished with the second layer of 5 mm thick cement plaster of 1:6 with water proofing compound

2.9.11 **Internal Finishes**

Requirements of internal finishes are furnished in Table-1 below

Sl. No.	Location	Flooring & skirting	Painting	Doors, Windows &ventillators
1.	VCB Building	a) Flat brick soling. b) 100 mm PCC (1:1.5:3) c) Double charged Vetrified Tiles (600x600 mm) d) 150 mm height skirting inside e) 600 mm height skirting neat cement finish outside	a) 20 mm thick cement plaster (1:4) b) Water proof wall putty. c) primer d) Weather coat (two coats)	a) Powder coated aluminum frame (2.00 mm thick) b) 6 mm thoughend glass. c) Glass Film as required

2.9.12 **Internal Electrification**

It is in the scope of the Contractor to design, install and commissioning of the complete electrification scheme of the buildings. Some of the general requirements of the internal electrification works are as follows: -

a) The internal electrification works shall be carried out in concealed wiring system with rigid conduits and 1.1 kV grade PVC insulated, stranded copper conductors.

b) Illumination level and type of lighting in various locations shall be as specified in ***Clause*** ***2.21.0*** of this Specification.

c) Sufficient numbers of 3-pin 6 ampere and 16 ampere sockets shall be provided at various locations as directed by the employer's representative.

d) No re-wire able fuses shall be used in electrical distribution circuits as far as practicable; instead MCBs of short circuit rating of not less than 10 KA should be provided.

e) In conceal wiring the earth wire shall be 1.1 kV grade PVC insulated, stranded copper conductor.

2.9.13 **Control Desk Wiring**

All wirings to control desk for HMI, telephones etc. shall be concealed type.

2.9.14 **Plumbing and Sanitation**

2.9.14.1. The Contractor shall provide all the required plumbing and sanitary requirement of the Control room Building with supply of materials and labour. The plumbing and sanitary system generally shall consist of following:

a) PVC 'Syntex' or equivalent make roof water tank of capacity not less than 1500 liter.

b) Galvanized M.S. pipe of medium class conforming to IS 1239 of required sizes shall be used for internal and external piping works (concealed system for all internal piping works) for potable water.

i) C.I. pipes with lead joints conforming to IS 1792 and diameter not less than 100 mm and 6 kgp.s.i shall be used for sanitary works along with all necessary fittings.

c) Toilet shall have the following minimum fittings: -

i) W.C. (Indian type), Orissa Pattern (530 X 410 mm) with all fittings.
ii) Urinal (430X260X350 mm) with all fittings.
iii) Wash Basin (560X400 mm) with all fittings.
iv) Bath Room Mirror (600X450X6mm thick).

v) C.P. brass towel rail (600X20 mm) with CP brass brackets.
vi) Soap Holder and liquid soap dispenser.

d) Water cooler for drinking water with adequate water storage capacity shall be provided and located near Control Room instead of near toilet block.

e) An eye & face fountain conforming to IS 1052 shall be provided for battery room

f) One number kitchen slab with full size granite tiles will be provided with below the staircase landing or at other location as instructed by site engineer along with stainless kitchen sink and sink cock with drain board (510 X 1040 X 178 mm bow depth). A suitable power plug and required light shall be provided for the kitchen rack.

g) All fittings, fasteners, grating shall be chromium plated.

h) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers. All items brought to the site must bear identification marks of the manufacturer.

2.9.14.2. **Septic Tank and Soak Pit**

Septic Tank of 20 user capacity and Soak pit shall be constructed at a place near to the Control Room Building. The design and drawings of the Septic Tank and Soak pit shall be submitted to the Employer for approval.

2.9.14.3. **Deep Tube Well**

The Contractor shall provide a deep tube well of size 100 mm diameter at each substation site. After completion of boring, before installation of strainer/ pipe, the contractor shall submit the logging of the bore well for record and approval of the Employer. The location of the strainer will be as per approval of the Employer. The installation shall be complete with minimum 1 HP single phase submersible pump set with electrical panel board, piping to overhead water tank. The minimum discharge rate shall be 1500 litres per hour continuous. **As required watertreatment plant shall be provided to make the water potable**. Regarding portability of water, report shall be submitted to the Employer for approval.

2.10.0 DESIGN OF BUILDINGS

2.10.1 **General**

The buildings shall be designed (if asked for):

i. To the requirements of the National Building Code of India, and the standards quoted therein.
ii. For the specified climatic and loading conditions

iii. To adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy

iv. With a functional and economical space arrangement

v. Be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.

vi. To allow for easy access to equipment and maintenance of the equipment.

vii. With, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.

viii. With materials preventing dust accumulation.

ix. Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

x. Individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.

xi. Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

xii. The building lighting shall be designed in accordance with the requirements.

xiii. One emergency exit shall be provided in control room building.

2.10.2 **Design loads**

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane load, wind loads, seismic loads, and temperature loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS: 1911.

Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipment to be supported on the building frame.

The wind loads shall be computed as per IS 875, Seismic Coefficient method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for the purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables piping travel of maintenance trucks and equipment and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Cable and piping loads shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Employer's approval.

For consideration of loads on structures, IS: 875, the following minimum superimposed live loads shall, however, be considered for the design.

a.	Roof		1.5 KN/M ^{2} 0.75 KN/M 2	For accessible roofs For in-accessible roofs
b)	RCC-Floor	i)	5 KN/M 2	For offices
		ii)	10 KN/M 2 (minimum)	For equipment floors or actual requirement, if higher than 10kN/M2, based on equipment component weight and layout plans.
c.	Toiler Room			2 KN/M2

d.	Chequered plate floor	4 KN/M2
e.	Walkways	3 KN/M2

Any additional load coming in the structure shall be calculated as per IS: 875.

2.11.0 SECURITY FENCING, GATES AND SECURITY BOOTH

2.11.1 **SECURITY FENCING**

2.11.1.1. Security fencing shall be constructed as per drawing supplied with the Bidding document.

2.11.2 **Security Gates**

2.11.2.1. The gate shall be made of medium duty M.S. pipe conforming to relevant I.S. with welded joints. The outer frame of main of the gate shall be made of 40 mm dia pipes (both vertical & horizontal) and intermediate vertical pipes of 15 mm dia at 125 mm spacing (maximum) shall be welded with the main frame as shown in the attached drawing.

2.11.2.2. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primmer and two coats of synthetic enamel paint.

2.11.2.3. The main gate shall be 5.5 (Clear m wide and shall be of double leaf type (as shown in the drawing). Next to the main gate, a side gate (1.25m wide single leaf) shall also be provided.

2.11.2.4. Steel roller shall be provided with the gate.

2.11.2.5. Gates shall be installed in locations shown on layout drawings.

2.11.2.6. Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism shall be fitted.

2.11.3 **Security Booth**

A Security room shall be provided at the entrance of switchyard. The minimum dimension of the room shall be 3.5 m length and 3.5 m width. The roof shall be RCC and aesthetically pleasing. Necessary doors and windows shall be provided for vigilance all around. The security booth shall be complete with lights & fans, paintings etc.

A telephone connection shall be provided from the local EPAX with a handset.

2.12.0 SUBMISSION

2.12.1 The following information shall be submitted for review and approval to the Employer as far as

Civil Works are concerned:

i) Contour Plan for substation area.

ii) 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.

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

iv) Fully, dimensioned concept plan including floor plans, cross-sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.

v) Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

vi) Product information of building components and materials, including walls partitions flooring ceiling, roofing, door and windows and building finishes.

vii) A detailed schedule of building finishes including colour schemes.

viii) A door and window schedule showing door types and locations, door lock sets and latch and other door hardware.

ix) 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.

2.13.0 BUS BARS AND BUS BAR SUPPORTS

2.13.1 The bus bars shall be outdoor strung bus bars with ACSR conductor supported on lattice

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

2.14.0 ACSR CONDUCTORS

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

2.14.2 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 7	Co-efficient pf linear expansion Number of strands	23x10-6 /0C	19.35x10-6 /0C	19.35x10-6 /0C
	Steel centre	1	1	1
	1st Steel Layer	6	6	6
	1st Aluminium Layer	12	12	12
	2nd Aluminium Layer	18	18	18
	3rd Aluminium Layer	24	24	-
8	Sectional area of Aluminium	528.50 mm2	428.90 mm2	212.10 mm2
9	Total sectional area	597.00 mm2	484.50 mm2	261.50 mm2
10 11	Calculated d.c. resistance at200 C Ultimate tensile strength	0.05552 ohm/km 161.2 kN	0.06869 ohm/km 130.32 kN	0.1400 ohm/km 89.67

2.14.3 Technical Overview of ALUMUNIUM TUBULAR BUS BAR

- The Aluminium tubular bus bar shall be extruded from 63401 grade Aluminium alloy with W.P. range 2 treatment. The rigid tubular conductors shall be of aluminium of standard type and designed to operate within set temperature limits and to withstand thermal and electro mechanical forces developed due to short circuits and vibration by wind. Material of Aluminium Tubular shall be cold drawn aluminium tube with minimum 55% IACS conductivity at 20o C temperature. (International Annealed Copper standards) 4.2 Dimensional tolerances of the aluminium tube shall be as laid down in IS:2673 for the extruded tube.

- Yield strength shall be based on tensile stress of 1335 kg/cm2 and the breaking strength shall be based on the tensile stress of 1545 kg/cm2.

- The temperature of tubular bas bar when carrying full load current shall not exceed 45oC above the site ambient temperature.

- The material shall be clean smooth and free from any harmful effect. Standard Aluminium pipes of dia size 4”. Pipe to pipe joint is to be avoided as far as practicable during erection. In case of Al tube jointing Argon welding process is to be adopted. Uses of very small pieces of Al tube is to be avoided as far as practicable in order to minimize no of joints. The aluminium tubular bus bar offered shall not have any sharp edges, cuts, abrasions, etc and shall be free from visible corona.

- The radio interference voltage level of the tubular bus bar shall be below 500 micro volts, at a voltage 20% above the highest line to earth value of the megahertz.

- Preference shall be given to the firms having ISO.
- The finished tubes shall be perfectly straight. Surface of the Aluminium tubes shall have a bright smooth finish, free from seams, cracks and other imperfections.
- The ingot to be used for producing the Aluminium tubular bus bars of grade 63401 W.P. shall comply with the requirements specified in Table 1 (Clause 6.1) of IS:5082 when analyzed in accordance with IS:504 or any other standard instrumental method of analysis.

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SPECIFIC TECHNICAL REQUIREMENT

a) Standard pipe size: 114.3mm (4”)
b) Material: Aluminium of grade 91E Confirming to IS:5082 of 1969
c) Atmosphere: Corrosive and fungicidal
d) Rated voltage :132 KV

The maximum length of tube that can be supplied with and without stationing limitations on transport stipulation shall be indicated in the Bid. Standard length of 7 meters for 4” IPS is preferred.

TEST:

Individual tubular bus bar shall be subjected to following tests:

a) Temperature rise test for rated current
b) Three second short circuit test
c) Critical disruptive voltage test for 4” IPS pipe
d) Yield strength
e) Chemical composition.

The bidder shall have to submit copies of Type test certificate of any Government recognized Laboratory for consideration along with the technical bid. The date of type test conducted should not be older than 10 years as on the date of opening of technical bid.

INSPECTION & TESTING:

a) The Board reserves the rights to inspect the materials at any stage of manufacturing. All acceptance tests as per relevant specification shall be performed in the presence of the Board’s inspecting authority. The Bidder will have to give intimation of place, Date and Time of such testing to the Board sufficiently in advance to enable the Board to depute its representative to be present at the testing. No material shall be dispatched without having been passed by Board’s representative. Routine/Acceptance tests shall have to be arranged by the Bidder, in accordance with the relevant standards free of cost for each lot of supply.

b) Inspection by the Board’s representative shall not relieve the Bidder from his obligation of furnishing material in accordance with the relevant specification.

PERFORMANCE:

The Bidder has to clearly state their experience, resources, engineering organization to undertake this work of supply. The Bidder shall have minimum experience of 3 years in the manufacture of similar items. However, the Board reserves the right to waive stipulation in respect of experience for new firms.

DRAWINGS:

Immediately, on receipt of the order, the Bidder should come with the necessary drawings for approval of the user department.

TECHNICAL REQUIREMENTS AND GUARANTEED TECHNICAL PARTICULRS: ----

(TO BE FILLED IN COMPLETELY AND SHALL BE SUBMITTED WITHTECHNICAL BID)

SR.NO	PARTICULARS	REQUIREMENTS
1.	Manufacturer's Name and address	
2.	Standards to which confirming	
3.	Type of tube	(Schedule 40) CEL section no. 8045
4.	Material Grade designation	IS 63401 WP
5	Moment of Inertia	301.039 cm2
6	Section Modulus	52.675 cm2
7	Radius of Gyration	3.835 cm
8	Modulus of Elasticity	6700 kg/mm2
9	Dc Resistance(max) at 20°C Micro ohms/m	15.3
10	Electrical conductivity	55% IACS (min)
11	Rated normal Current at 50 c/s (indoor)	2800 Amps.
12	Rated normal Current at 50 c/s (outdoor)	3050 Amps
13	Outer diameter of tube	114.3mm +1.20/-0.00 mm
14	Thickness of tube	6.02mm +0.70/-0.00 mm
15	Area of 4" IPS tube	2048 mm
16	Normal weight of tube	5.53 Kgs/Mtr.
17	Density	2.7gm/cubic cm
18	Minimum UTS	20.5 kg/sq.mm
19	Temperature co-eff of Resistance	0.00364/°C
20	Minimum elongation on 50mm	10%
21	Minimum 0.2% proof stress	17.34 kg/sq.mm
22	Chemical Composition	
a)	Copper	0.05%
b)	Magnesium	0.4-0.9%
C)	Silicon	0.3-0.7%
d)	Manganese	0.03%

e)	Iron	0.5%
F)	Zinc	0.1%
g)	Titanium	0.1%
h)	Chromium	0.03%
i)	Other	0.03% each, total 0.1%
j)	Aluminium	Remainder

2.15.0 ELECTRICAL CLEARANCES

2.15.1 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

2.16.0 EARTHING SYSTEM

2.16.1 General

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

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

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

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

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

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

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

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

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

(j) One number 40 mm 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 elctrodes must also be connected to the Main Earth Mat of the substation.

2.16.2 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, Cable Trench Support etc.	50mm x 6 mm	GI Flat
5	Rod Earth Electrode	40mm dia, 3000	Mild Steel

		mm long	
6	Pipe Earth Electrode (in treated earth pit) as per IS 3043.	40mm dia, 3000 mm long	Galvanised Steel

2.17.0 PROTECTION AGAINST DIRECT LIGHTNING

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

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

2.17.3 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.

2.17.4 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 earthmat.

2.17.5 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.

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

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

2.18.0 BAY MARSHALLING KIOSKS

2.18.1 One number of bays marshalling kiosk shall be provided for each 132 kV bay and one number kiosk shall be provided for each two numbers of 33 kV bays 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) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum four outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

ii) To distribute minimum six outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.

2.18.2 The steel sheet thickness of BMK shall be minimum 3.15 mm and painting shall be as per Clause 2.24.0.

2.18.3 The BMK shall be protective class of IP 55.

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

2.19.0 INSULATORS AND HARDWARE FITTINGS

2.19.1 **General**

(i). 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.

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

(iii). 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.

(iv). 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.

(v). 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.

(vi). 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.

(vii). Security clips/split pins shall be made of good quality of stainless steel.

(viii). 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.

(ix). 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.

2.19.2 **Disc Insulator Strings**

2.19.2.1. 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

2.19.2.2. **Parameters of 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, subject to	
	requirement of clause 2.19.2.1)	: 25 mm/kV
h)	Electro mechanical Strength	:70 KN for Suspension String/ 90 KN
i)	Power frequency withstand test voltage	For Tension string : 75 KV Dry
i)	Power frequency withstand test voltage	: 75 KV Dry
j)	Minimum dry Impulse withstand	: 125 KV peak
	Test voltage (+/- wave)	
k)	Puncture Voltage	: 1.3 X actual dry flash over voltage

2.19.4 **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
3.	Impulse voltage withstand test	510 kV	650 kV	170 kV
4.	Minimum Creepage Distance	6125 mm	3625 mm	900 mm
5.	Minimum Bending Strength (upright)	6 kN	4 kN	3 kN

2.20.0 CLAMPS, CONNECTORS AND SPACERS

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

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

i. For connecting ACS Aluminium alloy casting conforming to designation, A 6 of IS 617
ii. For connecting equipment: terminals made of copper
iii. For connecting GI Shield wire:
iv. Expansion Connectors
v. Bolts, nuts, plain washers: and spring washers for items (i), (ii) and (iii).

2.20.3 **Spacers**

Bimetallic connectors made from aluminiumalloy casting conforming to designation A 6 of IS 617. Malleable iron casting.
Copper lamination to grade FRTP-2 of IS 191.

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

i. At intervals not exceeding 2.5 meters in case of strung bus bars or other bundled strung conductors.

ii. At one meter interval in case of jumper connections.

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

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

v. At intervals not exceeding 2.5 meters in case of strung bus bars or other bundled strung conductors.

vi. At one meter interval in case of jumper connections.

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

2.21.0 ILLUMINATION SYSTEM

2.21.1 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	

2.21.2 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.

2.21.3 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	Florescent	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

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

2.22.0 FIRE FIGHTING EQUIPMENT

2.22.1 All the equipment in the switchyard and control room shall be protected by portable fire extinguisher. These fire extinguishers are to be put at appropriate locations in and around control room and switchyard.

2.22.2 Relevant Indian Standards or equivalent shall govern the Portable fire extinguishers.

2.22.3 The fire fighting equipment shall consist of following:

(i). Carbon Dioxide type fire extinguishers (capacity 3 kg) - 5 nos.

(ii). Dry Chemical Powder (DCP) type fire extinguishers (capacity 5 kg) - 5 nos.
(iii). Fire Bucket with sand (9 liter) – 4 nos.
(iv). Wheel / trolley mounted Dry Chemical Powder (DCP) type fire extinguishers (capacity 25 kg)- 2 nos.
(v). Wheel / trolley mounted Foam type fire extinguishers (capacity 50 kg)- 2 nos.

2.22.4 Necessary fixtures/ covered stands / covered shade etc. shall also be provided for safekeeping of the above items.

2.23.0 PAINTING

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 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 (30-40μm)	Epoxy high build micaceous iron oxide (75 μm)	Aliphatic Polyurethane 2 coats (25 μm/coat)	Minimum 155 μm	Shade No. 631 of IS:5
-do- (**Internal surfaces**)	Shot Blast cleaning Sa 21/2 (ISO 8501-1)	Hot oil resistant, non-corrosive varnish or paint or epoxy	-	-	Minimum 30 μm	Glossy white for paint
Marshaling boxes, operating boxes etc (**External**	Chemical/ Shot Blast cleaning Sa 21/2 (ISO 8501-1)	Epoxy base zinc primer (30-40μm)	Epoxy base zinc primer (30-40μm)	Polyurethane 2 coats (25 μm/coat)	Minimum 110 μm	Light Gray, Shade No. 697 of IS: 5

surface)						
-do- (**Internal surfaces**)	Chemical/ Shot Blast cleaning Sa 21/2 (ISO 8501-1)	Epoxy base zinc primer (30-40µm)	-	-	Minimum 30 µm	Glossy white for paint
Smaller fasteners, Cable clips						Use non-ferrous material or Stainless steel

2.23.2 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.

2.23.3 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.

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

2.23.5 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.

2.24.0 FURNITURE

2.24.1 The contractor shall also be required to provide furniture in the Control Room. Contractor shall supply the furniture from make of repute (preferably Godrej). The items to be supplied by the contractor shall be:

i. Table, 2.5m x 1.5 m, steel frame with laminated particleboard top with lockable shelves and drawers – 2 nos.
ii. Swivel padded Chair with castel wheels, arm rests, high flexible backrest etc. – 2 nos.
iii. Padded steel chairs with armrest standard chair – 8 nos.
iv. Steel glass front with 5 shelf (adjustable) Bookcase – 2 nos.

2.25.0 SUBSTATION T & P

2.25.1 Following Tools & Plants of reputed make are in the scope of supply of the Contractor:

Sl No	Item Description	Unit	Number
1	Chain Pully Block 5T capable of lifting up to ten feet	No	1
2	Tirfur capable of pulling 5 Ton load	No	1
3	Derek	No	1
4	Hand gloves (to operate 33KV) & Boots free size	Set	4
5	Hook Stick (Folding type) resin bond	2	2
6	Tool box		

6.1	Pliers of various sizes – 6”, 8”, 12”	Set	1
6.2	Insulated Screw drivers of various size – 6” to 18”	Set	1
6.3	Wire Stripers – 6”	No	2
6.4	Slide wrench – 12” & 18”	Set	2
6.5	Nose Pliers – 6”	No	2
6.6	Ratchet Spanner of various sizes (8 to 42 mm)	Set	1
6.7	Wire crimping tool – upto 16 mm	No	1
6.8	Drill machine and drill bits – Power operated (upto 19 mm)	Set	1
6.9	Grinder – Power operated (6”)	No	1
6.10	Vernier Caliper – 8”	No	1
6.11	Box Spanner – Ring & D-Spanner (6 to 42 mm)	Set	1
6.12	Flat, Round & half Round Files – 12”	Set	1
6.13	Hexes of various sizes – 4”, 6”	Set	1
6.14	5 kV (with step 500V, 1000V, 2500V) Motorised Insulation Tester of Megger make,	No	1
6.15	Digital Multimeter	No	1
6.16	Tongue Tester (Capable of measuring AC & DC current 1A to 500A and Voltage up to 700V, accuracy 0.5%)	No	1
6.17	Tongue Tester (Capable of measuring AC & DC current 1mA to 2A, accuracy 0.5%)	No	1
7	16 mm steel rope (50 m) and 20 mm polypelene rope (100 m)	Set	1
8	Slings of various sizes and capable of carrying 5 Ton load – ½”, ¾”	Set	1
9	SF6 Gas Leakage Detector	Set	1
10	DC Earth Fault Tester, Fluke make	No	1
11	Wheel cart Ladder, 8 M high	No	1
12	Transformer Oil test Kit (0 – 100 kV motorised) with accessories	No	1
13	Infra-Red Thermo vision Camera, Fluke makeTi 32	No	1

2.26.0 SUPPLY OF CONSTRUCTION MATERIALS BY THE CONTRACTOR

2.26.1 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.

2.26.2 **Cement**

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

a) The contractor shall procure cement (approved BSI marked of PPC of Grade 53), required for the work sonly 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.

d) 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.

e) 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.

f) 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.

g) 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.

2.26.3 **Steel**

The Contractor shall procure mild steel reinforcement bars, high yield strength deformed (HYSD) bars, rods and structural steel, etc., required for the works, only from the main or secondary producers manufacturing steel to the prescribed specifications of Bureau of Indian Standards or equivalent and licensed to affix ISI or other equivalent certification marks and acceptable to the Engineer-in-Charge. Necessary ISI list certificates are to be produced to Engineer-in-Charge before use on works. The unit weight and dimensions shall be as prescribed in the relevant Indian Standard specification for steel.

2.27.0 SUPPLY OF CONSTRUCTION MATERIALS BY THE EMPLOYER

2.27.1 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.

2.28.0 MISCELLANEOUS GENERAL REQUIREMENTS

2.28.1 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.

2.28.2 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.

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

2.28.4 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.

2.28.5 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 75 kg/cm2 compressive strength before submitting his offer.

2.28.6 Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

2.28.7 All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm. Service ladder shall be provided for access to all roofs. RCC fire escape staircase shall be provided in control buildings.

2.28.8 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.

2.28.9 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.

2.28.10 Hand-railing minimum 900 mm high shall be provided around all floor/roof openings, projections/balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS:277). All rungs for ladder shall also be galvanized as per IS: 277 medium classes.

For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats shall be provided with black PVC sheathing.

2.28.11 The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.

2.28.12 Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope

SECTION 3

(A) SPECIFICATION FOR DESIGN AND FABRICATION OF SUBSTATION STEEL STRUCTURES

3.1.0 SCOPE

3.1.1 The scope of this section covers specifications for design fabrication, proto-assembly, supply and erection of galvanised steel structures for towers, girders, lightning masts and equipment support structures. All structures shall be lattice type structure fabricated from structural steel conforming to IS 2062 (latest*).*

3.1.2 Single Line Drawings of towers, beams and equipment support structures for standard Bus Bar support and equipment mounting structures are supplied with this bidding document except mounting structures for Circuit Breakers and Isolators. Contractor shall only use these single line drawings for preparation of fabrication drawings. Support structures for circuit breakers and isolators shall be designed by the Contractor and approved by the Employer. Any other structures, if necessary to complete the substation to complete the work in all respects shall be designed by the contractor.

3.1.3 In case of equipment support structure, Contractor may require to change the dimensions to match the equipment bus bar height and to match the mounting arrangement of a particular equipment. Further, suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. The Contractor will make these changes without any price implication. The final drawings of mounting structures shall be submitted to Employer for approval.

3.1.4 The scope shall include supply and erection of all types of structures including bolts, nuts, washers, hangers, shackles, clamps ant-climbing devices, bird guards, step bolts, insert in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the job.

3.2.0 MATERIALS

3.2.1 Structural Steel

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

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

3.2.2 Bolts

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

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

Foundation Bolts shall conform to IS 5624.

Step bolts shall conform to IS 10238

3.2.3 Nuts

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

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

3.2.4 Washers

Washers shall conform to IS 2016. Heavy washers shall conform to IS 6610. Spring washers shall conform to type 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. Galvanisation process shall be automatic one. Structural steel galvanized manually will not be accepted. The bidder has to submit galvanization process chart including machineries.

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 IS 802 but for loading combinations specified hereunder. Computation of wind loading on structural members, conductors, insulators, etc. and other parameters shall be as specified in IS 802 except otherwise specified in this Specification.

3.3.2 The switchyard structures shall be designed for following loads considered acting simultaneously:

(i) Wire tension

(ii) Wind Load

(iii) Short Circuit Forces

(iv) Weight of supported wires, insulators, equipment etc and self-weight of structures.

An additional load of 3000 N shall be considered acting for weight of lineman and tools. For beams this 3000 N load shall be considered acting at middle of the beam.

3.3.3 The design shall be checked for following two loading conditions:

(A) Normal Conditions (all wires intact)

Under this condition, the loads shall be taken as under:

(i) Wire Tension: - Maximum Wire tension as specified in Clause 3.3.5.

(ii) Wind Load: - Loads due to 100% Design Wind Pressure (after accounting for drag coefficient and gust factor) on structures, wires, insulators, equipment etc. Design wind pressure shall be as per Clause 3.3.4.

(iii) Short Circuit Forces: Loading due to a 3-phase short circuit current of 40 kA, 31.5 kA and 25 kA shall be considered for 220 KV,132 kV and 66 kV & 33 kV respectively subject to minimum of 10% of maximum wire tension as considered in

(i) above.

(iv) Dead Weight: - All dead loads mentioned in Clause 3.3.2 (iv) shall be considered. Conductor and shield wire weight shall be calculated using spans as per Clause 3.3.6.

(B) Broken Wire Condition

Under this condition design shall be checked with all wires broken on one side and load shall be as under:

(i) Wire Tension: - Wire tension for intact wires shall be taken as 100% of Clause 3.3.3 (A) (i). For broken wires it shall be taken as zero.

(ii) Wind Load: -Same wind load as calculated in Clause 3.3.3 (A) (ii) shall be considered.
(iii) Short Circuit Forces: - Short circuit forces shall be considered only for intact wires.
(iv) Dead Weight: - Same dead load as calculated in Clause 3.3.3 (A) (iv) shall be considered.

3.3.4 **Design Wind Pressure**

The Design Wind pressure for the purpose of this Specification shall be taken as 793 N/m2. This wind pressure corresponds to Terrain Category 2 and Reliability Level 1 as per IS 802 (Part 1/Section 1).

3.3.5 **Wire Tensions**

For design purpose tension in each power and shield wires shall be taken as under a. For Power Conductors

(i) 220 kV Switchyard
- 10000 N for each conductor between Line Gantry and Dead-End Tower of Transmission Line.
- 8000N foreachBusBarconductorandother jumpers/jack buses.

(ii) 132 kV, 66 kV and 33 kV switchyard.
- 8000 N for each conductor between Line gantries and Dead-End Tower of Transmission Line.

6000 N for each Bus Bar conductor and other jumpers/jack buses.

b. For Shield Wires

(i) 220 KV132 kV, 66 kV and 33 kV Switchyard. — 6000 N for shield wire between Line gantry and Dead-End Tower of Transmission Line.

5000 N for shield wires at other Location.

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

3.3.6 **Spans**

Following Spans shall be considered in design of all structures as applicable: -a).
Line gantries (structures to terminate lines):

(i)	For 220, 132, and 66 KV Switchyard:	150 Meter, wind span
		150 Meter, weight span
(ii)	For 33 KV Switchyard:	50 Meter, wind & weight span.

b). All other Structures

(i)	For 220 KV Switchyard:	75 Meter, wind & weight span
(ii)	For 132 KV Switchyard:	50 Meter, wind & weight span
(iii)	For 33 KV Switchyard:	20 Meter, wind & weight span.

3.3.7 **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.

3.3.8 **Conductors and Shield Wires**

A) Following sizes of power conductors ***if not otherwise specified in the drawings,*** shall be used for design of structures:

a). For 132 kV switchyard: -

(i) ACSR 'PANTHER' conductor (two conductors per phase) for Main Bus Bars and jumpers between two segregated Main Bus Bars.

(ii) ACSR 'PANTHER' conductor (one conductor per phase) for Transfer Bus Bars (if any) and for other locations including line gantry to Dead End tower of Transmission lines.

b) For 33 kV switchyard: -

(i) ACSR 'PANTHER' conductor (two conductors per phase) for Main Bus Bars and jumpers between two segregated Main Bus Bars.

(ii) ACSR 'PANTHER' conductor (one conductor per phase) for Transfer Bus Bars (if any) and for other locations including line gantry to Dead End tower of Transmission lines.

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

3.4.0 DESIGN DRAWINGS

3.4.1 As and where asked for the relevant drawings for all the towers, beams and equipment mounting structures shall be furnished by the Contractor to the Employer which shall include structural/erection drawings, shop fabrication drawings, Bill of Materials, foundation-working drawings.

3.4.2 The structural/erection drawings, Bill of materials and shop fabrication drawings for all thestructures shall be submitted in four copies and will be finally approved by the Employer. Thefabrication shall be taken up from the approved shop drawings. The overall responsibility offabricating structure members correctly lies with the Contractor only and the Contractor shallensure 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 than16mm diameter and 175mm long spaced not more than 450mm apart and extending from 2.5meters above the ground level to the top. Each step bolt shall be provided with two nuts onone end to fasten the bolt securely to the tower and button head at the other end to preventthe 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**

i. Single suspension and tension insulator string assemblies shall be used for stringingBusbars.For the attachment of Suspension Insulator string, a suitable strain plate ofsufficient thickness for transferring the load to the tower body shall be provided. Toachieve requisite clearances, if the design calls for providing extra D-shackles, link plateetc. before connecting the 1nsulator string the insulator string the same shall be suppliedby the Contractor.

ii. At tension points strain plates of suitable dimensions placed on the beams, shall beprovided for taking the hooks or D-shackles of the tension insulator strings. To achieverequisite 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

3.6.0 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 inCompression	5
Other members	4

3.6.2.2 **Drilling and Punching**

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.

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

a) Holes must be perfectly circular and no tolerances in this respect are permissible.
b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm. i.e., the allowable taper in a punched holes should not exceed 0.8 mm on diameter.
c) Holes must be square with the plates or angles and have their walls parallel.

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, filing, bending and matching are completed. Galvanising shall be done by the hot dip process as recommended in IS: 2629 or other such authoritative international standards and shall produce a smooth, clean and uniform coating of not less than 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 galvanized 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 galvanized, but oiled only.

3.7.3 The outside surface shall be galvanised. Sample of galvanised materials shall be supplied to the galvanising test set out in IS 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 diagonally opposite legs of the towers/columns/mounting structures. The holes shall be suitable for bolting 65 mm X 12 mm GI strips and shall be such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earthing strip.

3.9.0 TEST AND TEST CERTIFICATE

3.9.1 Each consignment ready for transportation shall be offered to AEGCL for inspection before

dispatch giving a minimum time of not less than 30 days. Samples of fabricated structure materials shall be subjected to following tests: -

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

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

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

Test at Contractor's Premises

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

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

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

SECTION-4

TECHNICAL SPECIFICATION FOR
POWER TRANSFORMERS

4.1.0 SCOPE:

4.1.1 This specification provides for design, manufacture, inspection and testing before dispatch, packing and delivery at destination sub-stations of transformers complete with all fittings, accessories, spares, unloading, handling, proper storage at site, associated equipments specified herein. The scope of work shall also include, supervision of Erection, Testing and Commissioning of all the equipments supplied under this specification.

4.1.2 It is not the intent to specify completely herein all details of the design and construction of equipments. However, the equipment shall conform in all respects standards of engineering, design and workmanship listed in clause no. 4.2.0 and shall be capable of performing in continuous commercial operation up to the supplier's guarantee in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment, is not in accordance therewith. The equipments offered shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of supplier's supply, irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.

4.1.3 The scope of supply includes the provision of training for Purchaser’s personnel (Limiting to 10 Persons for minimum of 05 days duration) in regard to design, manufacture, assembly, testing, operation and maintenance of offered transformer at his works in the event of order, free of cost to AEGCL.

4.2.0 STANDARDS:

4.2.1.0 The Transformer and associated accessories shall conform to the latest issues of the standards as given below, except to the extent explicitly modified in this specification.

(1) CBIP manual on Transformer. Pub. No. 295 / 317

(2) ‘Standard Specifications and technical Parameters for Transformers and Reactors (66 kV & above voltage class)’ of CEA vide ‘File No.CEA-PS-14-169/2/2019-PSETD Division Dated: April, 2021’

(3) Power Transformers IS: 2026

(4) Fittings and accessories for power transformers IS: 3639

(5) Insulating oils for transformers and switchgears IS: 335

(6) Bushings for alternating voltages above 1000 V IS: 2099

(7) Gas operated relays IS: 3638

(8) Code of practice for installation and maintenance IS: 10028 of transformers

(9) Colours for ready mix paints. IS: 5

(10) Industrial cooling fans. IS: 6272

(11) Guide for loading of oil immersed transformers. IS: 6600

4.1.1.1 In case equipment conforms to other international standard which ensure equivalent or better performance than that specified under **Clause 4.3.0,** then relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

4.1.1.2 For further reference regarding standards **Annexure-V (List of Codes/Standards/ Regulations/Publications)** shall be followed.

4.3.0 GENERAL REQUIREMENT:

4.3.1.0 The transformers shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and the purchaser shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

4.3.1.1 The Transformer offered by the contractor shall at least conform to the requirements specified under relevant IS/IEC standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. If the IS standard is not available, then other applicable international standard (IEC/Equivalent), as per the specification, shall be accepted.

4.3.1.2 The equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the tropical conditions mentioned in General Technical Requirement (GTR), of this bidding document.

4.3.1.3 The transformers shall in general have constant ohmic impedance between HV and IV on all taps. However, in case of transformer to be connected for parallel operation:

i) The percentage impedance, vector group, OLTC connection and range etc. of the transformers shall be matched.

ii) Necessary provision is to be kept in the transformer control scheme for parallel operation with the OLTC control scheme having provision of Master/Follower/Independent /Off operation etc.

iii) External or internal reactors shall not be used to achieve the specified HV/LV and IV/LV impedances.

4.3.1.4 The Transformer shall be multi-winding, oil immersed complying as per Specific technical parameters and suitable for outdoor installation.

4.3.1.5 The transformer of manufacturer having same or higher MVA rating and same or higher voltage class must be in successful operation in any STATE or CENTRAL utility for not less than five (5) years as on date of NIT.

4.3.1.6 Components having identical rating shall be interchangeable.

4.3.1.7 **Rated Capacity and Voltage of the Transformers as per present requirement of AEGCL:**

a) 500 MVA - 400/220/33 KV Auto Transformer with loaded 33 KV tertiary winding.
b) 160 MVA - 220/132 KV Auto Transformer

4.4.0 SPECIFIC REQUIREMENT:

(i) Type Test:

The transformers should be Type Tested as per IS 2026 or IEC 60076 in conjunction with their relevant Part. Necessary test documents of previously tested similar or higher rated (both in MVA and voltage class) transformer shall have to be submitted with the bid.
Materials, which have never been tested for critical performance, shall not be accepted.
Type test certificates shall be acceptable only if: -

(a) Tests are conducted in an independent and well known (**NABL/BIS** Accredited) testing laboratory, or
(b) 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 clients or purchaser.

Test reports to be acceptable must be related directly to the materials offered. Test reports for higher class of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment(s) after the award of contract.

Type Test Reports older than five (5) years on the date of technical bid opening shall not be accepted.

The Validity of type test report of Station Service Transformer shall be as per CEA's "Guideline for 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).

Full Type Test Reports of at least the following equipment must be submitted: -

1. **500, 160, 100 and 50 MVA class Power/Auto Transformer**
2. **Tap Changer**
3. **Transformer Oil**
4. **Bushings**
5. **Buchholz Relay**
6. **Pressure Relief Device**
7. **Bushing Current Transformer**
8. **Oil Surge Relay**
9. **Cooling Gears**
10. **AVR Relay**
11. **On line drying system**

(ii) Dynamic Effect of Short Circuit:

For 400 kV Class Auto transformer

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit test on 315MVA or above rating 400/220/33kV or 400/230/33kV, 3-Phase Auto transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report/certificate along with bid. In case bidder/manufacturer has not successfully tested 315MVA or above rating 400/220/33kV or 400/230/33kV, 3-Phase Auto transformer for Dynamic Short Circuit test, their bid shall be considered technically non responsive. Further, design review of offered 400kV Class Auto transformer shall be carried out based on the design of short circuit tested 315MVA or above rating 400/220/33kVor 400/230/33kV, 3-Phase Auto transformer.

For 220 kV Class Transformer:

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on any rating of 220 kV or above voltage class transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report / Certificate along with bid. In case bidder has not successfully tested 220 kV or above voltage class transformer for Dynamic

Short Circuit Test, their bid shall be considered technically non-responsive. The offered transformer should comply the requirement of similarity clause specified in IS 2026 (PART 5) / IEC 60076-5 with respect to short circuit tested transformer. Further, design review of offered transformer shall be carried out based on the design of short circuit tested transformer.

(iii)Sweep Frequency Response Analysis (SFRA/FRA) shall have to be carried out as special test for each transformer at manufacturer's premises in presence of representative of AEGCL free of cost. Test result shall have to be handed over to AEGCL. Before commissioning of the Transformer at site, the same SFRA/FRA test will have to be carried by the test engineers of the manufacturer in presence of customer's representative for comparing the results to take the decisions of the commissioning. The Testing Engineers & FRA kit for such pre-commissioning site testing shall have to be arranged by the manufacturer free of cost.

(iv)Tests at Manufacturer's works: The Transformers shall be subjected to type & routine test, special tests and no load & load loss measurement as per relevant IS.

(v)Guaranteed Technical Particulars: The Bidder shall furnish all guaranteed technical particulars as called for in this specification along with each copy of Bid submission. Bids lacking information in this respect may not be considered.

(vi)Core Materials: Core materials should be directly procured from either the manufacturer or their accredited reputed marketing organization and not through any agent.

4.5.0 Guaranteed Technical Particulars

4.5.1.0 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in the prescribed Schedules 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.

4.5.1.1 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.

4.6.0 Liquidated Damages and Rejection for Excessive Losses

4.6.1.0 The no-load loss, load loss and auxiliary losses (cooler loss) as well as total losses shall be guaranteed under penalty for each transformer subject to Clause 4.6.1.2 and 4.6.1.3. For the purpose of penalty computation, the test figures of the no-load and the total losses of each transformer will be compared with the corresponding guaranteed figures.

4.6.1.1 The no-load losses, load losses and auxiliary losses shall not exceed the values specified in the **Maximum losses** Clause (i.e., Clause 4.6.1.3). No positive tolerance on no-load loss, load loss and auxiliary losses as well as total losses will be allowed. Any change in the figures assigned for transformer losses will not be permitted after opening of bids and evaluation will be carried out on the basis of information made available at the time of bid opening. Bid with higher losses as that of provided in the Technical Data Sheet, bid will be treated as non-responsive.

4.6.1.2 The capitalization of power/auto transformer losses shall be as per formula given **in SECTION AA of CBIP Manual on Transformers, 2013 (Publication No. 317).** The calculation results should be submitted to AEGCL for final approval.

The loss figures (both guaranteed & test) for the purpose of this clause shall be at rated frequency and voltage and at principal tap and 75º C.

4.6.1.3 **Maximum losses:**

While the bidders may offer their own design, the maximum limit of losses which include tolerance, but **Standard Fixed Losses for Transformers and Shunt Reactors as per Central Electricity Authority (CEA) letter CEA/PSE&TD/218/3056-4028 dated 01.03.19** shall be as below:

Sr. No	Rating (MVA)	Voltage Rating (kV)	Phase	No Load Loss (kW)	Load Loss (kW)	I^2R (kW)	Stray + Eddy (kW)	Aux. Loss
1.	500	400/220/33	3- Phase	AT 90	500	375	125	15
2.	160	220/132	3- Phase	AT 30	200	145	55	6
3.	100	220/33	3- Phase	AT 43	245	200	45	5
4.	50	132/33	3- Phase	AT 25	125	105	20	3

4.7.0 Transportation

4.7.1.1 The Contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimension of the equipment shall be such that when packed for transportation, it will comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the contractor to coordinate the arrangement for transportation of the transformer for all the stages from the manufacturer's work to site.

4.7.1.2 The contractor shall carry out the route survey along with the transporter and finalise the detail methodology for transportation of transformer and based on route survey; any modification/ extension/ improvement to existing road, bridges, culverts etc. if required, shall be in the scope of the contractor.

4.7.1.3 The inland transportation of the Transformer shall be on trailers equipped with GPS system for tracking the location of transformer at all times during transportation from manufacturer works to designated site. Contractor shall monitor / track the location of the trailer on regular basis and also provide tracking details to respective site/employer at the time of despatch of Transformer from factory to designated site. Requirement of Hydraulic trailer is envisaged for a load of more than 40 T.

4.7.1.4 All metal blanking plates and covers which are specifically required to transport and storage of the transformer shall be considered part of the transformer and handed over to the Purchaser after completion of the erection. Bill of quantity of these items shall be included in the relevant drawing/document.

4.7.1.5 The Contractor shall despatch the transformer filled with dry air/N2 at positive pressure. The necessary arrangement shall be ensured by the contractor to take care of pressure drop of dry air/N2 during transit and storage till completion of oil filling during erection. A dry air/N2 pressure testing valve with necessary pressure gauge and adaptor valve shall be provided. Generally, the duration of the storage of transformer at site with dry air/N2, shall preferably be limited to three months, after which the Transformer shall be processed as per the recommendation of manufacturer if not filled with oil. The dry air/N2 cylinder(s) provided to maintain positive pressure can be taken back by the contractor after oil filling.

In case turret, having insulation assembly, is transported separately then positive dry air/N2 pressure shall be ensured.

4.7.1.6 The Transformer shall also be fitted with at least 2 numbers of **electronic impact recorders** (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact, which can be withstood by the equipment during transportation and handling in all three directions, shall not exceed "3g" for 50mSec (20Hz) or as per contractor standard, whichever is lower.

4.7.1.7 Vendor/EPC shall remove the electronic impact recorders after reaching the Transformer main foundation Location in front of AEGCL representative. Transformer manufacturer/EPC shall stop the electronic impact recorders and soft copy shall be handed over to AEGCL Site representative. EPC/Vendor shall return the electronic impact recorders to Manufacture factory, this hardcopies of report with the values (softcopy shall also be downloadable at site) to be submitted by Vendor at AEGCL Design cell/ Project Team.

4.8.0 Performance

4.8.1.0 The transformers shall be used for bi-directional flow of rated power. The major technical parameters of three phase transformer units are defined at **Annexure – A.**

4.8.1.1 Transformers shall be capable of operating under natural cooled condition up to the specified load. The forced cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate as a forced cooling unit initially ONAF up to specified load and then as OFAF (or ODAF as specified). Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg C. If the Transformer is fitted with two coolers, each capable of dissipating 50 per cent of the loss at continuous maximum rating, it shall be capable of operating for 20 minutes in the event of failure of the oil circulating pump or blowers associated with one cooler without the calculated winding hot spot temperature exceeding 140 degC at continuous max rating. The contractor shall submit supporting calculations for the above and the same shall be reviewed during design review.

4.8.1.2 The transformer shall be free from any Electrostatic Charging Tendency (ECT) under all operating conditions and maximum oil velocity shall be such that it does not lead to static discharges inside the transformer while all coolers are in operation.

4.8.1.3 The transformers shall be capable of being continuously operated at the rated MVA without danger, at any tapping with voltage variation of +/-10% corresponding to the voltage of that tapping.

4.8.1.4 The transformers shall be capable of being over loaded in accordance with IEC-60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

4.8.1.5 Tank hotspot shall not exceed 130 Deg. Celsius. Maximum ambient temperature shall be considered as 50 Deg. C.

4.8.1.6 The transformer and all its accessories including bushing/ built in CTs etc. shall be designed to withstand without damage, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 2 secs. The short circuit level of the HV & IV System to which the transformers will be connected is as follows:

400kV system – 63 kA for 1 sec (sym, rms, 3 phase fault)
220kV system - 50 kA for 1 sec (sym, rms, 3 phase fault)
132kV system - 40 kA for 1 sec (sym, rms, 3 phase fault)
33kV system – 31.5 kA for 1 sec (sym, rms, 3 phase fault)

However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only (i.e., Zs = 0).

4.8.1.7 Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault for transformer rated voltage applied to HV and / or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals as applicable. The tertiary terminals shall be considered not connected to system source. For short circuit on the tertiary terminals, the in-feed from both HV & IV system shall be limited by the transformer self-impedance only and the rated voltage of HV and IV terminals shall be considered. The maximum short circuit output current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof. The transformer shall be designed to withstand for short circuit duration of 2 seconds for Thermal stress and the same shall be verified during design review.

4.8.1.8 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that under 10 % continuous over-voltage condition it does not exceed 1.9 Tesla at all tap positions.

4.8.1.9 Transformers shall withstand without damage, heating due to the combined voltage and frequency fluctuations which produce the following over fluxing conditions:

110 % for continuous
125 % for 1 minute
140 % for 5 seconds

Withstand time for 150% & 170% over fluxing condition shall be indicated. Over fluxing characteristics up to 170 % shall be submitted.

4.8.1.10 The air core reactance of HV winding of transformer shall not be less than 20% for 400kV class Transformer.

4.9.0 Tertiary Windings (if applicable as per Annexure - A)

4.9.1.0 The tertiary windings shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching and shall be suitable for connection to LT Transformer for auxiliary supply. All the windings shall be capable of withstanding the stresses which may be caused by such switching. The tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals and for 1/3rd of the MVA capacity of the transformer although the cooling for continuous thermal rating of the tertiary winding shall be for 5MVA capacity. Tertiary, if not loaded, i.e. not connected to reactor, capacitor or LT transformer etc., its terminals shall be insulated to avoid any accidental short circuiting.

If required, the surge arrester (with polymer housing) shall be provided externally in proximity with bushings mounted suitably on the transformer tank. Alternatively, if required, the surge arrester may be mounted internally (as per standard practice of manufacturer), in order to limit the transfer surge within the BIL specified. Further, in case external surge arresters are required, same shall be mounted on Transformer tank.

4.10.0 Radio Interference and Noise Level

4.10.1.0 The transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth so as to minimise interference with communication circuit.

4.10.2.0 The noise level of transformer, when energised at normal voltage and frequency with fans and pumps running shall not exceed the values specified at **Annexure - A**, when measured under standard conditions.

4.11.0 Measurable Defects

4.11.1.0 The following shall constitute as Measurable Defects for the purpose of Defect Liabilities as per relevant clauses of GCC / SCC of the bidding document:

a) Repair, inside the Transformer and OLTC (including oil migration) either at site or at factory is carried out after commissioning.
b) The concentration of any fault gas is more than values of condition-1 indicated in clause no 6.5 of IEEE-C57.104-2008, which are as detailed below:

H2	**CH4**	**C2H2**	**C2H4**	**C2H6**	**CO**	**CO2**	**TDCG**
100	**120**	**1**	**50**	**65**	**350**	**2500**	**720**

c) The winding tan delta goes beyond 0.005 or increase more than 0.001 within a year w.r.t. pre-commissioning values. No temperature correction factor shall be applicable for tan delta.
d) The moisture content goes above 12 ppm at any temperature during operation including full load.

4.12.0 Design review

4.12.1.0 The transformer shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. The manufacturer will be required to demonstrate the adequate safety margin w.r.t thermal, mechanical, dielectric and electrical stress etc. shall be maintained during design, selection of raw material, manufacturing process etc. in order to achieve long life of transformer with least maintenance and to take into account the uncertainties of his design and manufacturing processes. The scope of such design review shall include but not limited to the requirement as mentioned at **Annexure – B**.

4.12.1.1 Design reviews shall be conducted by Purchaser or an appointed consultant during the procurement process for transformers; however, the entire responsibility of design shall be with the manufacturer. Purchaser may also visit the manufacturer's works to inspect design, manufacturing and test facilities at any time.

4.12.1.2 The design review will commence after placement of award and shall be finalised before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the transformer under the scope. It shall be conducted generally following the "CIGRE TB 529: Guidelines for conducting design reviews for power transformers".

4.12.1.3 The manufacturer shall provide all necessary information and calculations to demonstrate that the transformer meets the requirements for short circuit strength and durability. The latest recommendations of IEC or Cigre SC 12 shall be applied for short circuit withstand evaluation.

4.12.1.4 **Type test requirement & it's validity**

The offered transformer or the transformer, the design of which is similar to the offered transformer, should have been successfully type tested within **last 5 years** as on the last date of submission of bid. Manufacturer may use same or different approved make of Bushings and other accessories used in type tested or short circuit tested unit in their transformer. Further, type test report of transformer shall only be acceptable provided the offered transformer has been manufactured from the same plant. Central Electricity Authority's "Guidelines for the validity period of type tests conducted on major electrical equipment in power transmission system" shall be followed regarding the validity of type tests of Bushings and other accessories.

4.13.0 Construction Details

4.13.1.0 The construction details and features of transformer shall be in accordance with the requirement stated hereunder.

4.13.1.1 Tank

4.13.1.1.1 Tank shall be fabricated from tested quality low carbon steel of adequate thickness. Unless otherwise approved, metal plate, bar and sections for fabrication shall comply with BS-4360 / IS 2062.

4.13.1.1.2 All seams and joints which are not required to be opened at site, shall be factory welded, and wherever possible they shall be double welded. Welding shall conform to BS-5135/IS 9595. After fabrication of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of BS-5500 table 4.4.3.1/IS 10801.

4.13.1.1.3 Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

4.13.1.1.4 The tank shall be of proven design either bell type with bolted /welded joint or conventional type with welded / bolted top cover. Bell type tank shall be provided with joint at about 500 mm above the bottom of the tank. The welded joint shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise at the joint.

4.13.1.1.5 Tank shall be provided with:

a. Lifting lugs: Four symmetrically placed lifting lugs shall be provided so that it will be possible to lift the complete transformer when filled with oil without structural damage to any part of the transformer. The factor of safety at any one point shall not be less than 2.

b. A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks. Each jacking pad shall be designed to support with an adequate factor of safety at least half of the total mass of the transformer filled with oil allowing in addition to maximum possible misalignment of the jacking force to the centre of the working surface.

c. Suitable haulage holes shall be provided.

d. 04 nos. of Gate valves for UHF sensors for PD Measurements (applicable for 400kV Transformer only) at various locations. Location of valves shall be finalized during design review.

e. Suitable provisions of pockets for OTI, WTI & RTDs including two spare pockets.

4.13.1.1.6 The tank shall be designed in such a way that it can be mounted either on the plinth directly or on rollers, as per manufacturer's standard practice.

4.13.1.1.7 The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without damage when using plates or rails and the base plate shall have following minimum thickness:

Length of tank (m)	Minimum plate thickness (mm)
Flat bases	
Over 2.5 m but less than 5m	20
Over 5 m but less than 7.5m	26
Over 7.5 m	32

4.13.1.1.8 Tank shall be capable of withstanding, without damage, severe strains that may be induced under normal operating conditions or forces encountered during lifting, jacking and pulling during shipping and handling at site or factory. Tank, tank cover and associated structure should be adequately designed to withstand, without damage or permanent deflection / deformation, the forces arising out of normal oil pressure, test pressures, vacuum, seismic conditions and short circuit forces specified.

4.13.1.1.9 Tank MS plates of thickness >12 mm should undergo Ultrasonic Test (UT) to check lamination defect, internal impurities in line with ASTM 435 & ASTM 577.

4.13.1.1.10 All pipes connected to Transformer shall follow IS 1239.

4.13.1.2 Tank Cover

4.13.1.2.1 The tank cover shall be designed to prevent retention of water and shall not distort when lifted. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the Buchholz relay.

4.13.1.2.2 At least two adequately sized inspection openings one at each end of the tank, shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.

4.13.1.2.3 The tank cover shall be provided with pockets for OTI, WTI and RTDs including 2 spare pockets. The location of pockets shall be in the position where oil reaches maximum temperature. Further, it shall be possible to remove bulbs of OTI/WTI/RTD without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

4.13.1.2.4 Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

4.13.1.2.5 To allow for the effect of possible induced and capacitive surge current flow, the tank cover and bushing turret shall be fixed to the transformer in such a way that good electrical contact is maintained around the perimeter of the tank and turrets.

4.13.1.2.6 The transformer shall be provided with a suitable diameter pipe flange, butterfly valve, bolted blanking plate and gasket shall be fitted at the highest point of the transformer for maintaining vacuum in the tank.

4.13.1.2.7

4.13.1.3 Gas venting

The transformer cover and generally the internal spaces of the transformer and all pipe connections shall be designed so as to provide efficient venting of any gas in any part of the transformer to the Buchholz relay. The space created under inspection /manhole covers shall be filled with suitable material to avoid inadvertent gas pockets. The Covers shall be vented at least at both longitudinal ends. The design for gas venting shall take into accounts the slopes of the plinth (if any) on which the transformer is being mounted.

4.13.1.4 Gasket for tank & cover

All gasketed joints in contact with oil shall be designed, manufactured and assembled to ensure long-term leak and maintenance free operation. All gasketed joints unless otherwise approved shall be of the O-ring and groove type. All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression.

All tank gaskets used shall be of NBR (Acrylonitrile butadiene Rubber generally known as NBR) and properties of all the above gaskets / O-Rings shall comply with the requirements of IS-11149 (Grade IV) Material selected shall suit temperature conditions expected to be encountered. Neoprene / cork sheets gaskets are not acceptable. The Gaskets and O-rings shall be replaced every time whenever the joints are opened.

4.13.1.5 Roller Assembly and Anti Earthquake Clamping Device

The roller mounted transformers are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer. The rail track gauge shall be 1676 mm. 3-Phase auto transformers of 400kV class shall have four (4) rails and other voltage class transformers shall have two (2) rails.

To prevent transformer movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation.

4.13.1.6 Conservator

4.13.1.6.1 Main tank conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. Conservator shall be fitted with magnetic oil level gauge with potential free high and low oil level alarm contacts, prismatic oil level gauge and Conservator Protection Relay (CPR)/Air cell puncture detection relay.

Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be installed to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

4.13.1.6.2 Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to top oil temperature of 110 deg C. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil.

4.13.1.6.3 The conservator shall be fitted with lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell and cleaning of the conservator as applicable.

4.13.1.6.4 Conservator shall be positioned so as not to obstruct any electrical connection to transformer.

4.13.1.6.5 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator. The main conservator tank shall be stencilled on its underside with the words **"Caution: Air cell fitted".** Lettering of at least 150 mm size shall be used in such a way to ensure clear legibility from ground level when the transformer is fully installed. To prevent oil filling into the air cell, the oil filling aperture shall be clearly marked. The transformer rating and diagram plate shall bear a warning statement that the **"Main conservator is fitted with an air cell".**

4.13.1.6.6 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth. The temperature of oil in the conservator is likely to raise up to 110 deg.C during operation. As such air cell used shall be suitable for operating continuously at this temperature.

4.13.1.6.7 The transformer manual shall give full and clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, and the recommended replacement intervals.

4.13.1.6.8 The conservator tank and piping shall be designed for complete vacuum / filling of the main tank and conservator tank. Provision must be made for equalising the pressure in the conservator tank and the air cell during vacuum / filling operations to prevent rupturing of the air cell.

4.13.1.6.9 The contractor shall furnish the leakage rates of the rubber bag/ air cell for oxygen and moisture. It is preferred that the leakage rate for oxygen from the air cell into the oil will be low enough so that the oil will not generally become saturated with oxygen. Air cells with well proven long-life characteristics shall be preferred. OLTC shall have conventional type conservator (without aircell) with magnetic oil level gauge with potential free oil level alarm contact and prismatic oil level gauge.

4.13.2.0 Piping works for conservator

4.13.2.1 Pipe work connections shall be of adequate size preferably short and direct. Only radiused elbows shall be used.

4.13.2.2 The feed pipe to the transformer tank shall enter the transformer cover plate at its highest point and shall be loaded straight for a distance not less than five times its internal diameter on the transformer side of the Buchholz relay, and straight for not less than three times that diameter on the conservator side of the relay. This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 5 degrees. The feed pipe diameter for the main conservator shall be not less than 80 mm.

4.13.2.3 This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 5 degrees. The feed pipe diameter for the main conservator shall be not less than 80mm.

4.13.2.4 A double flange valve of preferably 50 mm and 25 mm size shall be provided to fully drain the oil from the main tank conservator and OLTC conservator tank respectively.

4.13.2.5 Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

4.13.3.0 Dehydrating Silica gel Filter Breather

4.13.1.0 Conservator of Main Tank and OLTC shall be fitted with a dehydrating silicagel filter breather. Connection shall be made to a point in the oil conservator not less than 50 mm above the maximum working oil level by means of a pipe with a minimum diameter of 25 mm. Breathers and connecting pipes shall be securely clamped and supported to the transformer, or other structure supplied by the contractor, in such a manner so as to eliminate undesirable vibration and noise. The design shall be such that:

a) Passage of air is through silica gel.
b) Silicagel is isolated from atmosphere by an oil seal.
c) Moisture absorption indicated by a change in colour of the crystals.
d) Breather is mounted approximately 1200 mm above rail top level.
e) To minimise the ingress of moisture three breathers (of identical size) for 220kV and above voltage class transformer and two breathers (of identical size) for below 220kV class transformer shall be connected in series for main tank conservator. Manufacturer shall provide flexible connection pipes to be used during replacement of any silica gel breather.
f) To minimise the ingress of moisture, two in series of identical size shall be connected to OLTC Conservator. Contractor shall provide flexible connection pipes to be used during replacement of any silicagel breather.

4.13.3.2 **Thermosyphon Filter:**

To extract the harmful constituents like water, acids etc. from oil, Thermosyphon filter of cylindrical shape with perforated steel trays filled with absorbents such as active alumina should be provided.

The filter assembly shall be mounted on the transformer as well as ground supported and connected with pipes and shut off valves. Suitable instructions required to be followed for commissioning, dismantlement and maintenance of filter arrangement, re-generation and storage of the absorbent etc. must be included in the instrumentation manual. A detailed drawing showing internal arrangement shall be submitted.

The oil & absorbent capacity required in the thermo-syphon filter is as under.

i) Quantity of oil: 1.0% of total oil by weight

ii) Quantity of absorbent: 0.2% to 0.25% of total oil by weight

4.13.4.0 Pressure Relief Device

4.13.4.1 One PRD of 150 mm Diameter is required for every 30000 Litres of oil. However, at least two numbers PRDs shall be provided. Its mounting should be either in vertical or horizontal orientation, preferably close to bushing turret or cover. PRD operating pressure selected shall be verified during design review. PRD shall be provided with special shroud to direct the hot oil in case of fault condition. It shall be provided with an outlet pipe which shall be taken right up to the soak pit of the transformer. The size (Diameter) of shroud shall be such that it should not restrict rapid release of any pressure that may be generated in the tank, which may result in damage to equipment. Oil shroud should be kept away from control cubicle and clear of any operating position to avoid injury to personnel in the event of PRD operation. The device shall maintain its oil tightness under static oil pressure equal to the static operating head of oil plus 20 kPa.

It shall be capable of withstanding full internal vacuum at mean sea level. It shall be mounted directly on the tank. Suitable canopy shall be provided to prevent ingress of rain water. One set of potential free contacts (with plug & socket type arrangement) per device shall be provided for tripping. Following routine tests shall be conducted on PRD:

a) Air pressure test
b) Liquid pressure test
c) Leakage test
d) Contact operation test
e) Dielectric test on contact terminals

4.13.5.0 Sudden Pressure Relay

4.13.5.1 One number of Sudden Pressure relay with alarm/trip contacts **(Terminal connection plug & socket type arrangement**) shall be provided on tank of transformer. Operatingfeatures and size shall be reviewed during design review. Suitable canopy shall beprovided to prevent ingress of rain water. Pressurised water ingress test for TerminalBox (routine tests) shall be conducted on Sudden Pressure Relay.

4.13.6.0 Buchholz Relay

4.13.6.1 Two numbers double float, reed type Buchholz relay shall be provided in series of the connecting pipe between the oil conservator and the Transformer tank with minimum distance of five times pipe diameters between them. Any gas evolved in the Transformer shall be collected in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling while the Transformer in service. Suitable canopy shall be provided to prevent ingress of rain water. Each device shall be provided with two potential free contacts **(Plug & socket type arrangement),** one for alarm / trip on gas accumulation and the other for tripping on sudden rise of pressure.

4.13.6.2 The Buchholz relay shall not operate during starting/ stopping of the transformer oil circulation under any oil temperature conditions. The pipe or relay aperture baffles shall not be used to decrease the sensitivity of the relay. The relay shall not mal-operate for through fault conditions or be influenced by the magnetic fields around the transformer during the external fault conditions. Pressurised water ingress test for Terminal Box (routine tests) shall be conducted on Buchholz relay.

4.13.7.0 Oil Surge Relay

Reed type Oil Surge Relay shall be provided individually to each tap changer diverter switches and one common OSR at OLTC conservator tank. Valves of required size are to be put before and after of each OSR. For 3-phase OLTC, there shall be two numbers OSR. It is preferable that each oil surge relays have independent indicators. OSR shall have two trip contacts.

4.13.8.0 Oil Temperature Indicator (OTI)

All transformers shall be provided with a dial type thermometer of around 150 mm diameter for top oil temperature indication with angular sweep of 270°. It shall have adjustable, potential free alarm and trip contacts besides that required for control of cooling equipment if any. A temperature sensing element suitably located in a pocket on top oil shall be provided. This shall be connected to the OTI instrument by means of flexible capillary tubing with stainless-steel armoured. Temperature indicator dials shall have linear gradations to clearly read at least every 2 deg C. Range of temperature should be 0- 150°C with accuracy of ±1.5% (or better) of full-scale deflection. The setting of alarm and tripping contacts shall be adjustable at site. Adjustable range shall be 20-90% of full-scale range. Heavy duty micro switch of 5A at 240V AC shall be used. The instruments case should be weather proof and having epoxy coating at all sides. Instruments should meet ingress protection class of IP55 as per IS 13947/IEC60529. The instruments should be capable of withstanding line to body high voltage of 2.5kV AC rms, 50Hz for 1 minute.

In addition to the above, the following accessories shall be provided for remote indication of oil temperature:

Temperature transducer with Pt100 sensor (As per ANNEXURE- J)

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degree centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IEC 60751-2 or equivalent. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil for OTI system and shall provide dual output 4-20mA for SCADA system. The transducer shall be installed in the Individual Marshalling Box. Any special cable required for shielding purpose, for connection between PT100 temperature sensor and transducer, shall be in the scope of Contractor. 4-20mA signal shall be wired to Digital RTCC panel / BCU for further transfer data to SCADA through IEC 61850 compliant communications.

4.13.9.0 Winding Temperature Indicator (WTI)

4.13.9.1 All Transformers shall be provided with a device for measuring the hot spot temperature of each winding (HV, IV and LV) with dial type thermometer of 150 mm diameter for winding temperature indication with angular sweep of 270° and shall have adjustable potential free alarm and trip contacts besides that required for control of cooling equipment if any. The setting of alarm and tripping contacts shall be adjustable at site. A temperature sensing bulb located in a thermometer pocket on tank cover should be provided to sense top oil. This shall be connected to the WTI instrument by means of flexible capillary tubing with stainless-steel armoured. WTI shall have image coil and auxiliary CTs, if required to match the image coil, shall be mounted in the Marshalling Box / cooler control cabinet. Temperature indicator dials shall have linear gradations to clearly read at least every 2°C. Range of temperature should be 0-150°C with accuracy of ±1.5% (or better) of full-scale deflection. Adjustable range shall be 20-90% of full-scale range.

Heavy duty micro switch of 5A at 240V AC shall be used. The instruments case should be weather proof and having epoxy coating at all sides. Instruments should meet ingress protection class of IP55 as per IS 13947 /IEC60529. The instruments should be capable of withstanding line to body high voltage of 2.5kV AC rms, 50Hz for 1 minute.

In addition to the above, the following accessories shall be provided for remote indication of oil temperature:

Temperature transducer with Pt100 sensor for each winding (As per ANNEXURE- J)
RTD shall be provided with Pt100 temperature sensor having nominal resistance of 100 ohms at zero degree centigrade. The Pt100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IEC 60751-2 or equivalent. The Pt100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil, Auxiliary CTs, if required to match the image coil, for WTI system and shall provide dual output 4-20mA for remote WTI and SCADA system individually. The transducer, Auxiliary CT shall be installed in the Individual Marshalling Box. Any special cable required for shielding purpose, for connection between Pt100 temperature sensor and transducer, shall be in the scope of Contractor. 4-20mA signal shall be wired to Digital RTCC / BCU panel for further transfer data to SCADA through IEC 61850 compliant communications.

The temperature indicators (OTI & WTI) shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

4.13.10.0 Optical sensors & temperature measuring unit

4.13.10.1.1 Optical temperature sensors shall be fitted on each Transformer unit. 16 number probes for 3-ph unit shall be provided. The optical sensors measuring system shall be of direct measurement non-calibrating type. All the sensors shall be brought out to separate optical sensor box or in Individual Marshalling Box mounted on transformer tank to facilitate measurement of temperature during service life on each unit.

4.13.10.1.2 In order to facilitate measurement of temperature from the optical sensors, temperature measuring unit/system having at least 16 channels shall be mounted inside the separate optical sensor box or Transformer Marshalling Box for each transformer unit**.** The measuring unit shall be capable to retain temperature data for at least 30 days with facility to download these data.

4.13.10.1.3 Temperature measuring unit/system shall be suitable for satisfactory operation with ambient conditions and IEC 61850 compliant to interface with Employer's SCADA system through FO port.

4.13.10.1.4 Location of optical temperature sensors inside the transformer shall be decided during design review.

4.13.10.1.5 The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certified representative.

4.13.10.2 Earthing Terminals

4.13.10.2.1 Two (2) earthing pads (each complete with two (2) nos. holes, M16 bolts, plain and spring washers) suitable for connection to 75 x 12 mm galvanised steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

4.13.10.2.2 Two earthing terminals suitable for connection to 75 x 12 mm galvanised steel flat shall also be provided on each cooler, individual/common marshalling box and any other equipment mounted separately. For the tank-mounted equipment like online drying/ Online DGA/ Optical Sensor Box etc. double earthing shall be provided through the tank for which provision shall be made through tank and connected through two flexible insulated copper links.

4.13.10.2.3 Equipotential flexible copper link of suitable size at least 4 Nos. for Tank mounted turret with tank and tank with cover and or Bell shall be provided. For other components like - pipes, conservator support etc. connected to tank shall also be provided with equipotential flexible copper link.

4.13.10.2.4 Each transformer unit should have provision for earthing and connected to grounding mat when not in service. For this purpose, all line Terminals shall also be earthed through neutral by flexible copper connection. Contractor shall provide suitable arrangement for the above. 1.1kV Grade PVC FR type cable of 16 sq.mm (minimum) shall be used for above connection. Neutral shall have provision for connection to ground by a brass/tinned copper grounding bar supported from the tank by using porcelain insulator. The end of the tinned/brass copper bar shall be brought to the bottom of the tank at a convenient point for making bolted connection to 75 X 12 mm GS flat connected to station grounding mat. The other end of the tinned/brass copper bar shall be connected to the neutral bushing through flexible conductor/jumper.

4.13.11.0 Core

4.13.11.1 The magnetic circuit shall be core type. Each limb shall be joined with top and bottom yokes. The laminations shall be made from high grade non-ageing cold rolled grain oriented (CRGO) silicon alloy of **HI -B** grade steel (as per **BIS / IEC**). Indian transformer manufacturers shall use core material as per above specification with BIS certification. Only those bidders who directly imported **CRGO** either from the manufacturer or through their accredited marketing organization of repute (and not through any agent) shall be considered. **In support of this requirement the bidder shall submit an undertaking in specified format (Annexure C) in the form of affidavit on Rs.100/- stamp paper, dulynotarized.**

Laminations of one particular thickness i.e., 0.23mm or 0.27mm or better (quoted grade and type) shall be used. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstance.

4.13.11.2 The CRGO shall be cut at Mill's authorized Processing unit only.

4.13.11.3 The temperature of any part of the core or its support structure in contact with oil shall not exceed 120 deg C under normal operating condition and 130 deg C under 10% over voltage and maximum ambient air temperature conditions of 50 deg C. Adequate temperature margin shall be provided to maintain the long-life expectancy for this material.

The hot spot temperature and surface temperatures in the core shall be calculated for over voltage conditions specified in the document and it shall not exceed 125 deg C and 120 deg C respectively.

4.13.11.4 Core and winding shall be capable of withstanding the shock during transport, installation and service and adequate provision shall be made to prevent movement of core and winding with respect to tank during these conditions.

4.13.11.5 All steel sections used for supporting the core shall be thoroughly sand / shot blasted after cutting, drilling and welding.

4.13.11.6 Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

4.13.11.7 The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.

4.13.11.8 Adequate lifting lugs will be provided to enable the core and windings to be lifted.

4.13.11.9 Single point core earthing should be ensured to avoid circulating current. Core earth should be brought separately on the top of the tank to facilitate testing after installation on all transformers. The removable links shall have adequate section to carry ground fault current. Separate identification name plate/labels shall be provided for the 'Core' and 'Core clamp'. Cross section of Core earthing connection shall be of minimum size 80 sq.mm copper with exception of the connections inserted between laminations which may be reduced to a cross-sectional area of 20 sq. mm tinned copper where they are clamped between the laminations.

4.13.11.10 In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

4.13.11.11 The insulation of core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank shall be able to withstand a voltage of 2.5 kV (DC) for 1 minute. Insulation resistance shall be minimum 500MΩ for all cases mentioned above.

4.13.11.12 The maximum flux density in any part of the core and yoke at the rated MVA, voltage & frequency shall be such that less than 10% continuous over voltage condition does not exceed 1.9 Tesla.

4.13.11.13 For consideration of over fluxing, the transformer shall be suitable for continuous operation for values of over fluxing at (i) 110% (ii) one minute for 125% and (iii) 5 seconds for 140% of rated voltage.

4.13.11.14 The Transformer shall be of **BOLTLESS** core design. The Bidders will furnish documentary evidence with proof of their experience and performance in such type of design.

4.13.11.15 When bell type construction is offered, suitable projecting guides shall be provided on core assembly to facilitate removal of tank. The supporting framework of core shall be so designed so as to avoid presence of pockets, which would prevent complete emptying of the tank through drain valve or cause trapping of air during oil filling.

4.13.11.16 Successful Bidder shall furnish calculation towards maximum peak value of magnetizing in- rush current and shall justify that the transformer will not trip due to this during initial charging and subsequent charging.

4.13.11.17 Oil ducts shall be provided where necessary to ensure adequate cooling. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

4.13.11.18 The prime core materials are only to be used. Bidders should furnish following document as applicable as a proof towards use of prime Core material to be submitted before the stage inspection:

(a) Invoice of supplier
(b) Mill's test certificate
(c) Packing List
(d) Bill of lading
(e) Bill of entry certificate by Custom.

(f) Description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the materials.
(g) Place of cutting of core materials

All parts of the cores shall be of robust design capable of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

4.13.11.19 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating.

4.14.0 Windings

4.14.1.0 General

- The manufacturer shall ensure that windings of all transformers are made in clean, dust proof (Cleanroom class ISO 9 or better as per ISO 14644-1), humidity-controlled environment with positive atmospheric pressure. The conductors shall be of electrolytic grade copper free from scales and burrs. Oxygen content shall be as per IS 12444.
- Epoxy bonded Continuously Transposed Conductor (CTC) shall be used in main winding for rated current of 400 A or more.
- The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and shall be non-catalytic and chemically inactive in transformer oil during service.
- Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.
- The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.
- The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalise the distribution of currents and temperature along the winding.
- The windings shall be designed to withstand the dielectric tests specified. The type of winding used shall be of time tested. An analysis shall be made of the transient voltage distribution in the windings, and the clearances used to withstand the various voltages. Margins shall be used in recognition of manufacturing tolerances and considering the fact that the system will not always be in the new factory condition.
- The barrier insulation including spacers shall be made from high density precompressed pressboard (1.15 gm/cc minimum for load bearing and 0.95 gm/cc minimum for non-load bearing) to minimize dimensional changes. Kraft insulating paper used on conductor should have density of >0.75 g/cc.
- The conductor insulation shall be made from high-density (at least 0.75 gm/cc) paper having high mechanical strength. The characteristics for the paper will be reviewed at the time of design review.

- Wherever required, electrostatic shield, made from material that will withstand the mechanical forces, will be used to shield the high voltage windings from the magnetic circuit.

- All winding insulation shall be processed to ensure that there will be no detrimental shrinkage after assembly. All windings shall be pre-sized before being clamped.

- Windings shall be provided with clamping arrangements which will distribute the clamping forces evenly over the ends of the winding. Either brazing/crimping type of connections are permitted for joints. It shall be time proven and safely withstand the cumulative effect of stress which may occur during handling, transportation, installation and service including line to line and line to ground faults /Short circuits. Manufacturer shall have system which allows only qualified personnel to make brazing or crimping joints.
- Winding paper moisture shall be less than 0.5%.
- **In the case of ICTs with tertiary**, the insulation of LV(Tertiary)windingshall be adequate to withstand surge voltages appearing across them as a result of transfer due to impulse striking on HV or IV terminals. **The transformershall be suitably designed so that the surges transferred to tertiary winding do not exceed the permissible limits** without the use of any external means such as surge capacitors etc. under any condition. The tenderer shall also state whether the transferred surges could be restricted to 170 KVP without the use of any external means. **The current density of the conductor used for tertiary winding shall not exceed the current density specified for the main winding**/conductor.

- The stacks of windings shall receive adequate shrinkage treatment before and after final assembly. Adjustable devices, if necessary, shall be provided for taking up possible shrinkage of coils if any, in service. The provision made in this respect shall be clearly brought out in theBid.

- **The conductors shall be transposed at suitable intervals in order to minimize eddy current** and to equalize the distribution of current and temperature along the windings.

- The transformer manufacturer should have in house availability of vapour phase Drying (VPD) plant for proper drying of the insulation. In case VPD facility is not available, the bidder will prove that the method of drying adopted by them is equivalent or better than VPD in terms of level of dryness and other benefits of VPD.

4.14.1.1 Bracing of Windings

- The windings and connections of all transformers shall be braced to withstand socks, which may occur during transport or due to switching and other transient conditions during service.

- The winding shall be clamped securely in place, so that they will not be displaced or deformed during short circuit. The assembled core and winding shall vacuum dried and suitably impregnated before removing from the treating tank.

- Coil clamping rings, if provided shall be of steel.

- If the transpose winding is built up of section of disc coils, separated by spacers, the clamping arrangements shall be such that equal pressures are applied to all columns of spacers. All such spacers shall be securely located, shall be of suitable material and shall receive adequate shrinkage treatment before assembly.

- Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

- Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

- Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive, be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

- Winding and connections shall be braced to withstand shocks during transport or short circuit.

- Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.

- Terminals of all windings shall be brought out of the tank through bushings for external connections.

- The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

- Coils shall be made of continuous smooth high-grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

- Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances. The TM is to submit the process at the time of the bid.

- Tappings shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of the transformer at all voltage ratios.

- Magnitude of impulse surges transferred from HV to LV windings by induction and capacitance coupling shall be limited to B.I.L. of LV winding.

4.14.1.2 Current carrying connections

The mating faces of bolted connections shall be appropriately finished and prepared for achieving good long lasting, electrically stable and effective contacts. All lugs for crimping shall be of the correct size for the conductors. Connections shall be carefully designed to limit hot spots due to circulating eddy currents.

4.14.1.3 Winding terminations into bushings

- Winding termination interfaces with bushings shall be designed to allow for repeatable and safe connection under site conditions to ensure the integrity of the transformer in service.

- The winding end termination, insulation system and transport fixings shall be so designed that the integrity of the insulation system generally remains intact during repeated work in this area.

- Allowances shall be made on the winding ends for accommodating tolerances on the axial dimensions of the set of bushings and also for the fact that bushings may have to be rotated to get oil level inspection gauges to face in a direction for ease of inspection from ground level.

- In particular, rotation or straining of insulated connections shall be avoided during the fastening of conductor pads (or other methods) on the winding ends onto the termination surfaces of the bushing.

- Suitable inspection and access facilities into the tank in the bushing oil-end area shall be provided to minimize the possibility of creating faults during the installation of bushings.

4.15.0 Transformer Loading

- The limits of temperature rise are given in general technical parameters.

- The transformer shall be capable of remaining in operation at full load without the measured winding hot spot temperature exceeding 150°C for:

    - 10 minutes with complete (i.e.,100%) failure of cooler system.
    - 20 minutes with 50% of cooler system in service.

- The permissible temperature of the top oil shall refer to the specific loading combination for which the total losses are the highest. Individual permissible winding temperature rise shall be considered relative to the specified loading combination which is the most severe for the particular winding under consideration.

4.15.0 Terminal Arrangement

Specific requirement of bushings and their ratings etc. are as per general technical parameters.

4.17.0 Bushings

- The electrical and mechanical characteristics of bushings shall be in accordance with IS: 2099 and IS: 3347 (Part-III/Section-I). Dimensions and requirements of condenser bushings shall be in accordance with IS 12676, 1989.
- Bushings shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout and movement along with the spare. Transformer with bushing erected and provided with proper support from one foundation to another foundation within the substation area. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137/DIN 42530. All details of the bushing shall be submitted for approval and design review.

- 420kV, 245kV, 145kV and 52kV Bushings shall be either of the following type:

 a) RIP (Resin Impregnated paper) condenser type with composite polymer insulator (housing)

 b) or RIS (Resin Impregnated Synthetic) condenser type with composite polymer insulator (housing).

 However, OIP (Oil impregnated Paper) with porcelain / composite polymer housing type is also acceptable for 52kV Bushings.

 36kV and below voltage class bushing shall be solid or oil communicating type with porcelain housing.

 No arcing horns shall be provided on any bushing.

 c) Condenser type bushings shall be provided with-

    a. Oil level gauge.
    b. Oil filling plug and drain valve if not hermetically sealed;
    c. Tap for capacitance/tan delta measurement.

 d) RIP/RIS type bushing shall be provided with tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.

 e) Where turret type current transformers are specified, the bushings shall be removable without disturbing the current transformers.

 f) Bushing for voltage of 52 kV and above shall be RIP/RIS bushing with composite polymer insulator. 36 kV and below voltage class bushing shall be solid porcelain or oil communicating type.

 g) No arcing horns shall be provided on the bushings. Bushing shall be as per technical particulars furnished. Bushings of identical rating shall be interchangeable to optimise the requirement of spares.

 h) RIP/RIS Bushing shall be specially packed to avoid any damage during transit and suitable for long storage, with non-returnable packing wooden boxes with hinged type cover. Without any gap between wooden planks. Packing Box opening cover with nails/screws type packing arrangement shall not be acceptable. Bushing oil end portion shall be fitted with metal housing with positive dry air pressure and a suitable pressure monitoring device shall be fitted on the metal housing during storage to avoid direct contact with moisture with epoxy. Alternatively, oil filled metal housing with suitable arrangement for taking care oil expansion due to temperature variations shall also be acceptable. Manufacturer shall submit drawing/ documents of packing for approval during detail engineering. Detail method for storage of bushing including accessories shall be brought out in the instruction manual.

 i) The terminal marking and their physical position shall be as per IEC: 60076.

 j) Tan delta measurement at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP & RIP) at Transformer manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.

k) Tan δ value of RIP / RIS condenser bushing shall be 0.005 (max.) in the temperature range of 20°C to 90°C. The measured Tan δ value at site of in-service bushing should not exceed by 0.001 w.r.t. factory results (measured at approx. similar temperature conditions) during warrantee period. Tan delta value of OIP Bushing shall be 0.004 (Max) measured at ambient temperature. The measured Tan δ value at site of in-service bushing should not exceed by 0.001 w.r.t. factory results during warrantee period.

l) Special precaution shall be taken to eliminate moisture from paper insulation during manufacture, assembly, transport and erection.

m) Bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Buchholz relay.

n) To accommodate the bushing current transformers, space provided on the various voltage class bushings shall be as under:

420kV: 400 mm *

245kV: 300 mm *
: 600 mm **

145kV: 100 mm *
: 300 mm **
: 600 mm ***

Note:
*** = for one BCT**
**** = For two BCTs**
***** = For three BCTs**

4.17.1.0 TerminalConnectors

- Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors should have been successfully type tested strictly as per IS:5561.

- **AllconnectionswithACSR/AAACconductorsshallbeNutandbolt type.**
- Connectors shall be of **electrolytic grade copper forged and silver plated/tinned.** No part of a clamp shall be less than 10 mm thick.

- Non-magnetic stainless-steel nuts, bolts and plain washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Instead of spring washers, check/lock nuts shall be provided.

- The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

4.17.2.0 Bushing current transformers

- Current transformers shall comply with IS:2705.

- It shall be possible to remove turret mounted CTs from the transformer tank without removing the tank cover. Necessary precaution shall be taken to minimize the eddy currents and local heat generated in the turret.

- All secondary leads shall be brought to a terminal box near each bushing. These terminals shall be wired up to the Cooler Control Cabinet using separate cables for each core/phase.

- Bushing CT parameters indicated in the specification are tentative and liable to change within reasonable limits. The Bidder shall obtain the Purchaser's approval before proceeding with design of Bushing CTs.

4.17.2.0 Terminal Marking

The terminal marking and their physical position shall be in accordance with IS: 2026 unless otherwise specified**.**

4.17.4.0 Neutral Formation and Earthing Arrangement

The neutral of the transformer shall be brought out through bushing. The neutral terminal of 3-phase transformer shall be brought to the ground level by a brass/tinned copper grounding bar, supported from the tank by using porcelain insulators. The end of the brass/tinned copper bar shall be brought to the bottom of the tank, at a convenient point, for making bolted connection to two (2) 75 x 12 mm galvanised steel flats connected to Employer's grounding mat.

4.18.0 Cooling Equipment and its Control

4.18.1.0 Cooling Equipment for Radiator Bank

- The cooler shall be designed using radiator banks or tank mounted radiators. Design of Cooling system shall satisfy the performance requirements.

- In case of separately mounted radiator bank arrangement, the main tank shall have provision such that cooler banks can be placed on either side of the main tank without the need of any extra member/pipe maintaining the electrical clearances.

- The radiator shall be of sheet steel in accordance with IS 513 and minimum thickness 1 mm. Each radiator bank shall be provided with the following accessories:

    - Cooling Fans, Oil Pumps, Oil Flow Indicator (as applicable)
    - Top and bottom shut off valve
    - Drain Valve and sampling valve
    - Top and bottom oil filling valves

- Air release plug
- Two grounding terminals for termination of two (2) Nos. 75x12 mm galvanised Steel flats.
- Thermometer pockets with captive screw caps at cooler inlet and outlet.
- Lifting lugs: Each radiator bank shall be detachable and shall be provided with flanged inlet and outlet branches. Expansion joint shall be provided on top and bottom cooler pipe connection.

- If radiators are directly mounted on tank, sufficient number of thermometer pockets fitted with captive screw cap on the inlet and outlet of tank side pipe of radiators shall be provided to record temperature during temperature rise test.

- One number standby fan shall be provided with each radiator bank.

- Cooling fans shall not be directly mounted on radiator. It may cause undue vibration. These shall be located so as to prevent ingress of rain water. Each fan shall be suitably protected by galvanised wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

- Two (2), 100% centrifugal or axial in line oil pumps, if applicable, (out of which one pump shall be standby) shall be provided with each radiator bank. Measures shall be taken to prevent mal-operation of Buchholz relay when all oil pumps are simultaneously put into service. The pump shall be so designed that upon failure of power supply to the pump motor, the pump impeller will not limit the natural circulation of oil.

- An oil flow indicator shall be provided for the confirmation of the oil pump operating in a normal state. An indication in the flow indicator and potential free contacts for remote alarm shall be provided.

- Valves shall be provided across the pump and oil flow indicator to avoid oil drain and long outage during maintenance / replacement of pump and oil flow indicator.

- Cooling fans and oil pump motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall be of premium efficiency class IE3 conforming to IS: 12615. Each cooling fan and oil pump motors shall be provided with starter, thermal overload and short circuit protection. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure equivalent to IP: 55 as per IS/IEC 60034-5.
- The cooler pipes, support structure including radiators and its accessories shall be hot dip galvanised or corrosion resistant paint should be applied to external surface of it.

- Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section of pipe work can be drained independently.

4.18.1.1 Cooling Equipment Control for Radiator banks

- Automatic operation control of fans/pumps shall be provided (with temperature change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic changeover of cooler control over entire cooling option. The setting shall be such that hunting i.e., frequent start-up operations for small temperature differential do not occur.

- Suitable manual control facility for cooler fans and oil pumps shall be provided. Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans and pump manually. The changeover to standby oil pump in case of failure of service oil pump shall be automatic.

- In addition to the traditional starting of fan and pump by winding & oil temperature, the starting of forced cooling shall be done if the load exceeds a current setting of 0.6 p.u. for 5 seconds. Furthermore, a one-week timer is required to check the healthiness of the cooling system on a routine basis for one hour at a time.

- Following lamp indications shall be provided in cooler control cabinet:
    - Cooler Supply failure (main)
    - Cooler supply changeover
    - Cooler Supply failure (standby)
    - Control Supply failure
    - Cooling fan failure for each bank
    - Cooling pump failure for each pump
    - Common thermal overload trip

- One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet and for single ph. Unit connection shall be extended further to CMB.

- The cooler control cabinet / Individual Marshalling box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the cooler control cabinet/Individual Marshalling box. All the CT secondary terminals in the cooler control cabinet shall have provision for shorting to avoid CT open circuit while it is not in use.

- All the necessary terminations for remote connection to Purchaser's panel shall be wired upto the Marshalling Box.

- The Contractor shall derive AC power for Cooler Control Circuitry from the AC feeder. In case auxiliary power supply requirement for Cooler Control Mechanism is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.

4.18.1.2 Unit cooler arrangement for transformer (if applicable)

The cooler shall be designed using Unit Cooler arrangement with capacity as specified in Annexure-A. Design of cooling system shall satisfy the performance requirements.

Each Unit Cooler shall have its own cooling fans, oil pumps, oil flow indicator, shut off valves at the top and bottom of at least 80 mm size, lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

An oil flow indicator shall be provided for the confirmation of the oil pump operating in a normal state. An indication shall be provided in the flow indicator to indicate reverse flow of oil/loss of oil flow.

Valves shall be provided across the pump and oil flow indicator to avoid oil drain and long outage during maintenance / replacement of pump and oil flow indicator.

Cooling fans and oil pump motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall conform to IS: 325/IEC34. Each cooling fan and oil pump motors shall be provided with starter thermal overload and short circuit protection. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure equivalent to IP: 55 as per IS: 4691/IEC: 34-5

The cooler, pipes, support structure and its accessories shall be hot dip galvanised or corrosion resistant paint should be applied to external surface of it.

Expansion joint shall be provided on top and bottom cooler pipe connections as per requirement.

Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section of pipe work can be drained independently.

4.18.1.2.1 **Cooling Equipment Control (OFAF or ODAF) for Unit Coolers (if applicable)**

i) Suitable manual control facility for unit cooler shall be provided.
ii) The changeover to standby unit cooler bank oil pump in case of failure of any service unit cooler shall be automatic.
iii) Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the unit cooler manually.
iv) Cooler fans & oil pumps of all unit coolers (except standby cooler) shall operate continuously. The starting of unit cooler shall be done as soon the Circuit Breaker of HV/IV/LV (as applicable) side is switched on.
v) Once started the cooling shall remain in operation as long as the transformer is in service. When the transformer is switched off the cooling shall continue to run for a further duration of 30 minutes. This timer shall be at least adjustable from 15 to 60 minutes. Further, a one-week timer is required to check the healthiness of the complete cooling system on a routine basis for one hour at a time. Spurious operation should however be avoided by appropriate settings. All settings shall be adjustable
vi) Adequate warning/ safety labels are required to indicate that the fans may start at any time.
vii) If any one group(s) is out of service and isolated, this shall not affect the automatic starting of the other unit cooler.
viii) Following lamp indications shall be provided in cooler control cabinet:
    - Cooler Supply failure (main)
    - Cooler supply changeover
    - Cooler Supply failure (standby)
    - Control Supply failure
    - Cooler unit failure for each unit cooler
    - No oil flow/reverse oil flow for pumps

· Thermal overload trip for each fan / pump

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet and for single ph. unit connection shall be extended further to CMB.

4.19.0 Paint system and procedures

The typical painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box / oil storage tank etc. shall be as given in **Annexure –D**. The proposed paint system shall generally be similar or better than this. The qualityof paint should be such that its colour does not fade during drying process and shall be able to withstand temperature up to 120 deg C. The detailed painting procedure shall be finalized during award of the contract.

4.20.0 Insulating Oil

a) The required transformer oil shall be in the scope of transformer manufacturer.
b) The supplier shall dispatch the transformer filled with Nitrogen. The Bidder shall take care of the weight limitation on transport and handling facility at site. Necessary arrangement shall be ensured by the supplier to take care of pressure drop of nitrogen during transit and storage till completion of oil filling during erection. A gas pressure-testing valve with necessary pressure gauge and adapter valve shall be provided.
c) The quality of the oil supplied with transformer shall conform to the oil parameters specified in this clause.
d) No inhibitors shall be used in the oil.
e) The oil samples will be drawn as follows:
   i) Prior to filling
   ii) Before and after heat run test
   iii) Before energizing

   All tests as per IEC: 60296 shall be conducted on all samples.
f) The insulating oil shall be subjected to testing in the oil manufacturer’s works, before supply, in the presence of the representative of AEGCL and the representative of the transformer manufacturer.
g) Sufficient quantity of oil necessary for first filling of all tanks, coolers and radiators at the proper level along with 10% extra oil by weight for topping up shall be supplied in non-returnable containers suitable for outdoor storage.
h) The Bidder shall warranty that characteristic of oil furnished shall comply with the requirements specified in IEC: 60296 with the latest amendment /revision and shall be suitable for EHV grade transformers.

(Note: The color of the barrels in which Naphthenic based transformer oil is to be supplied shall be Red)
Insulating oil shall be virgin high grade inhibited, conforming to IS 335 / IEC-60296 & all parameters specified at **Annexure – E**, while tested at oil supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned at **Annexure – E**, prior to despatch of oil from refinery to site. The Unused Inhibited Insulating Oil parameters including parameters of oil used at manufacturer’s works, processed oil, oil after filtration and settling are attached at **Annexure – E**. The oil test results shall form part of equipment test report. Sufficient quantity of oil necessary for maintaining required oil level in case of leakage in tank, radiators, conservator etc. till the completion of warranty period shall be supplied.

Oil used for first filling, testing and impregnation of active parts at manufacturer's works shall be of same type of oil which shall be supplied at site and shall meet parameters as per specification.

4.20.1.0 Particles in the oil

The particle analysis shall be carried out in an oil sample taken before carrying out FAT at manufacturer's works and after completion of the oil filtration at site. The procedure and interpretation shall be in accordance with the recommendation of CIGRE report WG-12.17- "Effect of particles on transformer dielectric strength". Particle limit as shown below shall be ensured by manufacturer, implying low contamination, as per CIGRE Brochure 157, Table 8. After filtration the oil is to be flushed and particle count to be measured.

Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 μm; 130 particle/100 ml with size ≥ 15 μm.

4.20.1.1 Oil filling

- Procedures for site drying, oil purification, oil filling etc. shall be done as per EMPLOYER Field Quality Plan (FQP).

- The duration of the vacuum treatment shall be demonstrated as adequate by means of water / dew point measurement with a cold trap or other suitable method. The vacuum shall be measured on the top of the transformer tank and should be less than 1mbar.

- Oil filling under vacuum at site shall be done with transformer oil at a temperature not exceeding 65°C. Vacuum shall not be broken until the Transformer is oil filled up to the Buchholz relays.

- The minimum safe level of oil filling (if different from the Buchholz level) to which the Transformer shall be oil filled under vacuum, shall be indicated in the manual.

- The Ultra High Vacuum type oil treatment plant (on returnable basis) of adequate capacity (**generally 6000** litres per hour and above) suitable for treatment of oil in EHV class Transformer shall be used. The plant shall be capable of treatment of new oil (as per IEC 60296) and reconditioning of used oil (as per IS: 1866/IEC: 60422 for oil in service) at rated capacity on single pass basis as follow:

  i) Removal of moisture from 100 ppm to 3 ppm (max.)
  ii) Removal of dissolved gas content from 10% by Vol. to 0.1% by vol.
  iii) Improvement of dielectric strength break down voltage from 20 to 70 KV
  iv) Vacuum level of degassing chamber not more than 0.15 torr/0.2 mbar at rated flow and at final stage. Machine shall have minimum of two degassing chambers and these should have sufficient surface areas to achieve the final parameters.
  v) Filter shall be capable of removing particle size more than 0.5 micron in the filtered oil.
  vi) Processing temperature shall be automatically controlled and have an adjustable range from 40 deg C to 80 deg C.

- The above oil treatment plant (Filtration unit) shall be arranged by the bidder at his own cost.

4.20.2.0 Transportation of Oil

The insulating oil for the Transformer shall be delivered at site generally not before 90 days from the date of commissioning, with prior information to the Employer, in view of risk involved in balk storage, pilferage and fire hazard. In case this oil is not filled in Transformer due to delay in commissioning, same oil shall be used only after testing and ensuring that oil parameters are well within the specified limits.

Insulating oil shall be delivered to the site in returnable oil drums / flexi bag / tanker. The oil drums / flexi bag / tanker shall be taken back without any extra cost to Employer within generally 45 days after utilisation of oil but in any case, before contract closing. However, the spare oil shall be delivered in non-returnable drums.

4.21.0 Valves

- All valves upto and including 100 mm shall be of gun metal or of cast steel/cast iron. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.
- Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.
- Each valve shall be provided with the indicator to show clearly the position (open/close) of the valve.
- All valves flanges shall have machined faces. Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.
- All valves in oil line shall be suitable for continuous operation with transformer oil at 115 deg C.
- The oil sampling point for main tank shall have two identical valves put in series. Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.
- Valves or other suitable means shall be provided to fix various on-line condition monitoring systems to facilitate continuous monitoring.
- Gland packing/gasket material shall be of “O” ring of nitrile rubber for all the valve’sflanges. All the flanges shall be machined.
- Type of valves shall be used for transformer as per following table. The location, size of valves for other application shall be finalised during design review.

Sl. No.	Description of Valve	Type
1	Drain Valve	Gate
2	Filter valve	Gate
3	Sampling Valve	Globe
4	Radiator isolation valve	Butterfly
5	Buchholz relay isolation valve	Gate
6	Sudden pressure relay	Gate
7	OLTC- tank equalizing valve	Gate /Needle
8	OLTC Drain cum filling valve	Gate
9	Valve for vacuum application on Tank	Gate
10	Conservator Drain valve	Gate
11	Aircell equalizing valve	Gate/ Globe/Ball
12	Valve for Conservator vacuum (top)	Gate
13	Filter valve for Cooler Bank (Header)	Gate

14	Cooler Bank isolation valve	Butterfly
15	Pump Isolation valve	Butterfly
16	Valve for N2 injection (NIFPS)	Gate
17	Valve for NIFPS Drain	Gate
18	Valve for UHF Sensors	Gate

- Flow sensitive conservator Isolation valve:

  a) In order to restrict the supply of oil in case of a fire in transformer, flow sensitive valve shall be provided to isolate the conservator oil from the main tank. The valve shall be flow sensitive and shut off when the flow in the pipe is more than the flow expected in the permissible normal operating conditions. It shall not operate when oil pumps are switched on or off. This valve shall be located in the piping between the conservator and the Buchholz relay and shall not affect the flow of oil from and to the conservator in normal conditions.

  b) When the flow from conservator to main tank is more than the normal operatingconditions, the valve shall shut off by itself and will have to be reset manually. Itshall be provided with valve open/close position indicator along with alarm contactindication in control room during closing operation of valve. This valve shall beprovided with locking arrangement for normal position and oil filling / filtrationposition. A suitable platform or ladder (if required) shall be provided to approachthe valve for manual reset. All valves shall be painted with a shade (preferably redor yellow) distinct and different from of main tank surface and as per the painting system and procedure specified.

- All valves shall be painted with a shade (preferably red or yellow) distinct and different from of main tank surface and as per the painting system and procedure specified.
- All hardware used shall be hot dip galvanised/strainless steel.

4.21.2 Cabling

4.21.2.1 Buchholz Relay, Magnetic Oil Level Gauge, Pressure Relief Device & Sudden pressure relay to be wired through unarmoured cable of 1.5 sq.mm (minimum), inside GI conduit, with no part exposed. Cable shall be protected by flexible stainless-steel pipe, at both ends as per requirement. Proper sealing arrangement to be provided at both ends to avoid ingress of water.

The cross section of “control cable” shall be 1.5 sq.mm (minimum) except for CT circuits which should be 2.5 sq.mm (minimum).

All other cables shall be armoured type and shall be routed through covered cable tray or GI conduit and shall be properly dressed.

Cable terminations shall be through stud type TB and ring type lugs. Typical Technical specification for cables is attached at **Annexure-M** Contractor shall provide type tested cables from approved sources. No type testing for cables is envisaged. Both ends of all the wires (control & power) shall be provided with proper ferrule numbers for tracing and maintenance. Further, any special cables (if required) shall also be considered included in the scope. All cable accessories such as glands, lugs, cable tags/ numbers etc. as required shall be considered included in the scope of supply.

Cabling of spare unit with isolator switching arrangement shall be in such a way that spare unit of transformer can be connected in place of faulty unit without physically shifting and all the control, protection, indication signals of spare unit shall be brought in common marshalling box of all the banks. From CMB all the control, protection and indication signals of R, Y, B and Spare units shall be transferred to Purchaser's Control panels / SCADA. Change-over of spare unit signals with faulty unit shall be done through Purchaser's C & R panels / SCADA level. Changeover of RTCC signals shall be carried out in CMB.

4.22.0 Tap Changing Equipment

Each transformer shall be provided with On Load Tap changing equipment as specified elsewhere.

4.22.1.0 ON Load Tap Changing (OLTC) Equipment (Oil type)

4.22.1.1 Main OLTC Gear Mechanism

Each three-phase transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load.

OLTC shall be motor operated suitable for local as well as remote operation. The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment. The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contacts shall be replaceable.

Necessary safeguards shall be provided to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer.

The OLTC oil chamber shall have oil filling and drain valve, oil sampling valve, relief vent and level glass. Oil sampling valve of minimum size, accessible from ground, shall be provided to take sample of oil from the OLTC chamber. It shall also be fitted with an oil surge relay which shall be connected between OLTC oil chamber and OLTC conservator tank.

Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer.

4.22.1.2 Local OLTC Control Cabinet (Drive Mechanism Box)

Each transformer unit of OLTC gear shall have following features:

- OLTC shall be suitable for manually handle operated and electrically motor operated. For local manual operation from Local OLTC Control cabinet (Drive Mechanism Box), an external handle shall be provided.
- OLTC's Local control cabinet shall be mounted on the tank in accessible position. The cranking device/handle for manual operation for OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with the following:
  a. Mechanical tap position indicator which shall be clearly visible from near the transformer.
  b. A mechanical operation counter of at least five digits shall be fitted to indicate the number of operations completed and shall have no provision for resetting.
  c. Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.

d. The manual control considered as back up to the motor operated on load tap changer control shall be interlocked with the motor to block motor start-up during manual operation.
e. The manual operating mechanism shall be labelled to show the direction of operation for raising the voltage and vice-versa.
f. An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.

- For electrical operation from local as well as remote, motor operated mechanism shall be provided. It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two controls to be in operation at the same time. Transfer of source in the event of failure of one AC supply shall not affect the tap changer. Thermal device or other means shall be provided to protect the motor and control circuit. The Local OLTC Drive Mechanism Box shall house all necessary devices meant for OLTC control and indication. It shall be complete with the followings:

i. A circuit breaker/contactor with thermal overload devices for controlling the AC auxiliary supply to the OLTC motor
ii. Emergency Push Button to stop OLTC operation
iii. Cubicle light with door switch provided with anti-condensation metal clad heaters to prevent condensation of moisture
iv. Padlocking arrangement for hinged door of cabinet
v. All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
vi. The cabinet shall be tested at least IP 55 protection class.

- All relays and operating devices shall operate correctly at any voltage within the limits specified below. In case auxiliary power supply requirement for OLTC DM Box is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.

Nominal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415 V	+/- 10%	50 +/- 5%	¾ Wire	Solidly earthed
240 V	+/- 10%	50 +/- 5%	½ Wire	Solidly earthed
220 V	190 V to 240 V	DC	Isolated 2 wire system	-
110 V	95 V to 120 V	DC	Isolated 2 wire system	-
48 V	-	DC	2 wire system (+) earthed	-

Note: Combined voltage and frequency shall be limited to +/- 10%

- In case auxiliary power supply requirement for OLTC DM Box is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.
- Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command only, until the control switch is returned to the off position between successive operations / repeat commands.
- Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated. In addition,

a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

- OLTC local control cabinet shall be provided with tap position indication for the transformer. Drive Mechanism shall be equipped with a fixed resistor network capable of providing discrete voltage steps or provide 4-20mA transducer outputs for tap position indication in CMB (for single phase unit) and input to Digital RTCC/SCADA system.
- 'Local-remote' selector switch shall be provided in the local OLTC control cabinet. In Local mode, all electrical commands from remote (i.e. from CMB, Digital RTCC, SCADA etc.) shall be cut-off/blocked. Electrical operations to change tap positions shall be possible by using raise/lower push buttons under local mode from DM Box. In remote mode electrical commands from CMB/ Digital RTCC/SCADA etc. shall be executed. The remote-local selector switch shall be having at-least two spare contacts per position.
- Following minimum contacts shall be available in DM Box, which shall be wired to CMB for single phase unit. Further these contacts shall be wired to Digital RTCC panel:

  a. INCOMPLETE STEP which shall not operate for momentary loss of auxiliary power.
  b. OLTC motor overload protection
  c. Supply to DM Motor fail
  d. OLTC IN PROGRESS
  e. Local / Remote Selector switch position
  f. OLTC upper/lower limits reached
- All relays, switches, fuses etc. shall be mounted in the OLTC local control cabinet and shall be clearly marked / labelled for the purpose of identification.
- A permanently legible lubrication chart if required shall be fitted within the OLTC local control cabinet.

4.22.1.3 OLTC Control from Common Marshalling Box (CMB)

It shall be possible to monitor, control/operate, the OLTC of all the three 1-phase transformers of a transformer bank from Common Marshalling Box. The control and monitoring terminations of a spare transformer unit (1-Ph) shall be brought to CMB. The necessary switching arrangement through male-female plug-in TB assembly shall be provided for replacing spare unit with any one of the faulty phase units for monitoring & control from CMB.

Independent-combined-remote selector switch, raise/lower switch and emergency stop Push Button shall be provided in the common marshalling box for OLTC control.

When the selector switch is in **independent** position, the OLTC control shall be possible from individual Local OLTC Control Cabinet (DM Box) only.

In '**combined position'**, raise-lower switch (provided in the CMB), shall be used to operate for bank of three single phase transformers from CMB.

In **'remote position'** control of OLTC shall be possible from Digital RTCC/SCADA etc.

From CMB, the operation of OLTC shall be for 3-phases of transformer units without producing phase displacement. Independent operation of each single-phase transformer from CMB/ Digital RTCC/SCADA will be prevented.

Following minimum **LED indications** shall be provided in CMB:

a. INCOMPLETE STEP
b. OLTC motor overload protection
c. Supply to DM Motor fail
d. OLTC IN PROGRESS
e. Local / Remote Selector switch positions of DM
f. OLTC upper/lower limits reached

g. 415V Main AC supply ON
h. 415V Standby AC supply ON.

Following **contacts** shall be wired to TBs in CMB for further wiring to C & R Panels.

a) 415V Main AC supply Fail
b) 415V Standby AC supply Fail

Following **contacts** shall be wired to TBs in CMB for further wiring to digital RTCC Panel:

(a) INCOMPLETE STEP
(b) OLTC motor overload protection
(c) Supply to DM Motor fail
(d) OLTC IN PROGRESS
(e) Local / Remote Selector switch positions of DM
(f) OLTC upper/lower limits reached
(g) 'Independent-combined-remote' selector switch positions of CMB

Further, OLTC Tap position Digital indications for all three 1-Ph Transformer units either separately or through selector switch shall be provided in CMB. The same shall also be wired to Digital RTCC Panel to display tap positions for all three 1-ph unit separately.

4.23.0 Digital RTCC Panel

The digital RTCC relay shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage Regulating features (referred as **Digital RTCC relay**) to remotely control and monitor OLTC.

The contractor shall also provide Digital RTCC panel consisting of 4 Nos. Digital RTCC relays. Further, one spare Digital RTCC relay shall also be provided in the same panel. Each digital RTCC relay shall be used to control 1 bank of transformers (i.e., 1 No. 3-Phase unit)

Digital RTCC relay shall be microprocessor based adopting the latest state of the art design & technology with in-built large display for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer / location, it could be customized to site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT / VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc.

All Digital RTCC Relays shall be of same make for smooth integration of these relays for parallel operations of all transformers in the substation.

The RTCC Panel shall be provided with digital RTCC relay having Raise/Lower push buttons, Manual/ Automatic mode selection features, Master / Follower/ Independent/Off mode selection features for control of OLTC. Touch screen option in the relay, instead of electrical push button/switch is also acceptable.

In Manual Mode: In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons.

In Auto Mode: In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points. An interlock shall be provided to cut off electrical control automatically upon recourse being taken to the manual control in emergency.

Master / Follower/ Independent/ Off mode

Master / Follower parallel operation is required with Group simultaneous feature in Digital RTCC relay. Master-follower scheme implies that controlled decision shall be taken by the Master and control actions (Raise/Lower tap position) shall be executed simultaneously by Master & Follower units. Same logic needs to be implemented in digital RTCC relays.

Master Position: If the digital RTCC relay is in master position, it shall be possible to control the OLTC units of other parallel operating transformers in the follower mode by operation from the master unit.

Follower Position: If the digital RTCC relay is in Follower position, control of OLTC shall be possible only from panel where master mode is selected.

Independent Position: In independent position of selector switch, control of OLTC shall be possible only from the panel where independent mode is selected. Suitable interlock arrangement shall be provided to avoid unwanted/inconsistent operation of OLTC of the transformer

Raise/Lower control: The remote OLTC scheme offered shall have provision to raise or lower taps for the complete bank of three 1-phase transformers / 3-Phase Transformers. Individual 1-phase OLTC operation shall not be possible from the remote-control panel.

Digital RTCC relays shall communicate with SCADA using IEC 61850 through FO port to monitor, parameterise & control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restriction in loading on multiple computers for downloading and analysing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time.

The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select these set points from SCADA, with a facility to have the possibility of additional set points command from SCADA.

Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. IEC- 61850 GOOSE messaging between Digital RTCC relays for OLTC parallel operation is not permitted. Suitable communication hardware shall be provided to communicate up to distance of 1km between digital RTCC relays. Scope shall also include communication cables between digital RTCC relays. Cables as required for parallel operation of OLTCs of all transformers (including existing transformers wherever required) from Digital RTCC relays shall be considered included in the scope of bidder.

The Digital RTCC relay shall have additional programmable Binary Inputs (minimum 7 Nos.) and Binary outputs (minimum 7 Nos.) for Employer’s future use. It shall be possible to have additional module for Binary Input / output as well as Analogue input module depending upon requirement.

The relays shall ensure positive completion of lowering/raising of the OLTC tap, once the command is issued from the relay. "Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be affected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.

Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:

a. INCOMPLETE STEP alarm
b. OLTC motor overload protection alarm
c. Supply to DM Motor fail alarm
d. OLTC IN PROGRESS alarm
e. Local / Remote Selector switch positions in DM Box
f. OLTC upper/lower limits reached alarm
g. OLTC Tap position indications for transformer units
h. Independent-combined-remote selector switch positions of CMB (In case of single-phase transformer)
i. 415V, AC Mail Supply Fail.
j. 415V, AC Standby Supply Fail

In case of parallel operation or 1-Phase Transformer unit banks, OLTC out of step alarm shall be generated in the digital RTCC relay for discrepancy in the tap positions.

4.24.0 SCADA Integration and Interconnection

All required power & control cables including optical cable, patch chord (if any) upto MB (for 3-Ph unit) shall be in the scope of contractor. Further, any special cable between MB (for 3-Ph unit) to switchyard panel room/control room shall be under the present scope. All cable from RTCC to OLTC Drive Mechanism Box shall be provide (if applicable).

Fiber optic cable, power cable, control cables, as applicable, between MB (for 3-Ph unit) or Common MB (for 1-Ph unit) to switchyard panel room/control room and power supply (AC & DC) to MB and integration of above said IEC-61850 compliant equipment with Substation Automation System shall be under the scope of EPC contractor.
Cooling and OLTC of transformers shall be monitored and controlled from SCADA.
SCADA Integration of online monitoring equipment (if applicable):

All the online monitoring equipment i.e., Online Dissolved Gas (Multi-gas) and Moisture Analyser, On-line insulating oil drying system (Cartridge type) etc. provided for individual transformer unit including Spare (if any), are IEC 61850 compliant (either directly or through a Gateway). The monitoring equipment are required to be integrated with SAS through managed Ethernet switch conforming to IEC 61850. This Ethernet switch shall be provided in IMB or CMB. The switch shall be powered by redundant DC supply (110V or as per available Station DC supply). Ethernet switch shall be suitable for operation at ambient temperature of 50 Deg. C.

4.25.0 Constructional features of Cooler Control Cabinet/ Individual Marshalling Box/ Common Marshalling Box/ Junction Box / Outdoor cubicle and Digital RTCC Panel:

Each transformer unit shall be provided with local OLTC Drive Mechanism Box, cooler control cabinet /individual marshalling box, Digital RTCC panel (as applicable) and common marshalling (for a bank of three 1-phase units) shall be provided.

Common marshalling box (for single phase unit) shall be floor mounted and of size, not less than 1600mm (front) X 650mm (depth) X 1800mm (height). Individual Marshalling Box and Cooler control Box shall be tank mounted or ground mounted. The gland plate hall be at least 450 mm above ground level (for ground mounted panel).

The cooler control cabinet / individual marshalling box, common marshalling box, Junction box and all other outdoor cubicles (**except OLTC Drive Mechanism box**) shall be made of stainless-steel sheet of minimum grade of SS304 and of minimum thickness of 1.6 mm (SS 316 for coastal area). Digital RTCC panel shall be made of CRCA sheet of minimum thickness of 2.5mm and shall be painted suitably as per **Annexure –D**.

The degree of protection shall be IP: 55 for outdoor and IP: 43 for indoor in accordance with IS 13947/IEC: 60947.

All doors, removable covers and plates shall be gasketed all around with suitably profiled. All gasketed surfaces shall be smooth straight and reinforced, if necessary, to minimize distortion to make a tight seal. For Control cubicle / Marshalling Boxes etc. which are outdoor type, all the sealing gaskets shall be of EPDM rubber or any better approved quality, whereas for all indoor control cabinets / Digital RTCC panel, the sealing gaskets shall be of neoprene rubber or any better approved quality. The gaskets shall be tested in accordance with approved quality plan, IS: 1149 and IS: 3400.

Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater and cubicle lighting with ON-OFF switch shall be provided in each panel.

The size of Common marshalling box shall not be less than 1600mm (front) X 650mm (depth) X 1800mm (height). All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application.

4.26.0 Current Transformer

Current transformers shall comply with IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).

It shall be possible to remove the turret mounted current transformers from the Transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

Current transformer secondary leads shall be brought out to a weather proof terminal box near each bushing. These terminals shall be wired out to common marshalling box using separate cables for each core.

Technical Parameters of Bushing CTs and Neutral CTs are enclosed at **Annexure – G.** The CT's used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection. BushingCurrent transformer parameters indicated in this specification are tentative and liable tochange within reasonable limits. The Contractor shall obtain Purchaser's approvalbefore proceeding with the design of bushing current transformers.

Secondary resistance and magnetising current characteristics of PX class (protection) (as per IEC) CT of same rating shall be similar. This is applicable for Neutral CT (outdoor) also and shall be reviewed during detail engineering.

4.27.0 Hand Tools:

One set of hand tools of reputed make packed in a carry bag/box broadly comprising of double ended spanners (open jaws, cranked ring, tubular with Tommy bar each of sizes 9mm to 24mm, one set each), adjustable wrenches (8 &12 inch one set), gasket punches (of different sizes used - one set), pliers (flat nose, round nose & side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle (one), adjustable hacksaw (one), and cold chisel (one), bushing handling and lifting tools with nylon rope/belt, chain block (2 Nos.) and D-Shackle shall be supplied.

4.28.0 Test Kit:

BDV Kit as per Annexure-N of specification.
Portable DGA Kit as per Annexure-O of Specification.

4.29.0 Fittings & accessories

The following fittings & accessories (as applicable) shall be provided with each transformer covered in this specification. The fittings listed below are not exhaustive and other fittings which are required for satisfactory operation of the transformer are deemed to be included:

- Conservator for main tank with aircell, oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge (with canopy) with high and low oil level alarm contacts and prismatic oil level gauge and Dehydrating Silicagel Filter Breather with flexible connection pipes to be used during replacement of any silicagel breather.

  Conservator for OLTC with drain valve, oil surge Relay, filling hole with cap, prismatic oil level gauge and Dehydrating Silicagel Filter Breather with flexible connection pipes to be used during replacement of any silicagel breather.

- Oil preservation equipment, Thermosyphon filter with valves.
- Pressure relief devices including canopy with special shroud to direct oil
- Sudden pressure relief relay including canopy.
- Buchholz relay double float, reed type with canopy and isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm / trip contacts (gas collecting device)
- Air release plug
- Conservator air cell rupture detection relay
- Inspection openings and covers
- Bushing of each type with metal parts and gaskets to suit the termination arrangement
- Winding & Oil temperature indicators
- Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs

- Protected type mercury or alcohol in glass thermometer or magnetic or micro-switch type dial type temperature indicator as applicable
- Rating and diagram plates (in Hindi & English) on transformers and auxiliary apparatus
- Roller Assembly (as per clause 17.10.1.6)
- On load tap changing gear, OLTC DM Box, Off Circuit Tap Changer (OCTC) individual marshalling box / Cooler control cabinet, Common Marshalling Box, Fibre optic sensor box and Digital RTCC Panel as applicable
- Cooling equipment
- Bushing current transformers, Neutral CT (if applicable)
- Oil flow indicators (if applicable)
- Terminal marking plates
- Valves schedule plate &All the valves as per clause 17.13.1.1.4, 17.13.1.1.7 and 17.21.1.
- **Valves List**: Bottom oil sampling valve, Drain valves, Filter valves at top and bottom with threaded male adaptors, Shut off valves on the pipe connection between radiator bank and Transformer tank, Shut off valves on both sides of Buchholz relay, Sampling gas collectors for Buchholz relay at accessible height, Valves for Radiators, Valve for vacuum application, Valve for on line DGA, valves for Drying out system, Flow sensitive conservator Isolation valve, Valve for UHF sensors, valves for NIFPS system etc.
- Ladder (suitably placed to avoid fouling with bushing or piping) to climb up to the transformer tank cover with suitable locking arrangement to prevent climbing during charged condition. Additional ladder for conservator in case it is not tank mounted.
- Suitable Platform for safe access of Flow sensitive non-return valve and buchholz relay shall be provided, in case these are not accessible from transformer top.
- Haulage lugs
- Neutral bus connection arrangement. (3-Phase Transformer)
- Brass/tinned copper grounding bar supported from the tank by using porcelain insulator and flexible conductor for earthing of neutral, HV & IV terminals.
- On line insulating oil drying system.
- Online Dissolved Gas (Multi-gas) and Moisture Measuring Equipment
- On line dissolved Hydrogen and Moisture Measuring Equipment
- Fibre optic sensor-based temperature measuring system.
- Nitrogen Injection Type Fire Prevention & Extinguishing System.
- Automatic MulsifireSystem (or High Velocity Water Spray System)
- RTCC All Cables (Power, control and shielded / twisted pair for 4-20mA cable from Transformer MB, Cooler control cubicle, etc. (as applicable) to CMB shall be under the present scope. Any special cable if required to be included upto panel/ employer's C&R panel.
- Managed Ethernet switch, LIU patch cords etc. shall be provided in CMB/MB. All IEC 61850 compliant signals from various monitoring equipment/accessories shall be wired upto the Ethernet switch.

4.30.0 Inspection and Testing

The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. The inspection envisaged by the Purchaser is given below. This is however not intended to form a comprehensive programme as it is Contractor's responsibility to draw up and carry out such a programme in the form of detailed quality plan duly approved by Purchaser for necessary implementation. All accessories and components of transformer shall be purchased from approved soured of purchaser. All process tests, critical raw material tests and witness / inspection of these testing shall be carried out as per approved manufacturing quality plan (MQP) by purchaser.

4.31.0 Factory Tests

The manufacturer shall be fully equipped to perform all the required tests as specified. Bidder shall confirm the capabilities of the proposed manufacturing plant in this regard when submitting the bid. Any limitations shall be clearly stated in.

The contractor shall bear all additional costs related to tests which are not possible to carry out at his own works.

The contractor shall carry out type & routine tests as per "**Annexure-H & Annexure-I".** All tests shall be done in line with IEC: 60076 and the test procedures asmentioned in "**Annexure-H".** Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the contractor.

4.32.0 Type Tests on fittings:

Following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with drawings and GTP of the equipment / fittings.

1) Bushing (Type Test as per IEC:60137 including Snap back & Seismic test for 400 kV and above voltage class bushing)
2) OLTC (Test as per IEC:60214 and IP-55 test on driving mechanism box)
3) Buchholz relay
4) OTI & WTI
5) Pressure Relief device Test (including IP 55 test in terminal box)
6) Sudden Pressure Relay Test (including IP 55 test in terminal box)
7) Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.
8) Air Cell (Flexible air separator) - Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per IS: 3400/ BS: 903/ IS: 7016
9) Marshalling & common marshalling box and other outdoor cubicle (IP-55 test)
10) RTCC (IP-43)

4.33.0 Pre-Shipment Checks at Manufacturer's Works

Check for inter-changeability of components of similar transformers for mounting dimensions.

Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

Before dispatch of Transformer from factory, following impact recorder settings are to be implemented for graphical analysis:

> 1g: Start recording
> 2g: Warning
> 3g: Alarm

Further, drop-out setting shall be 1g and threshold setting shall be in the range of 5g to 10g.

Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

Gas tightness test to confirm tightness and record of dew point of gas inside the tank. Derivation of leakage rate and ensure the adequate reserve gas capacity.

4.34.0 Inspection and Testing at Site

The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage up to commissioning stage. An indicative programme of inspection as envisaged by the Purchaser is given below. However, it is contractor's responsibility to draw up and carry out such a programme duly approved by the Purchaser. Testing of oil sample at site shall be carried out as per specification.

4.35.0 Receipt and Storage Checks

Check and record condition of each package, visible parts of the transformer etc. for any damage. Check and record the gas pressure in the transformer tank as well as in the gas cylinder. Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

Check and record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendations.

4.36.0 Installation Checks

Inspection and performance testing of accessories like tap changers, cooling fans, oil pumps etc. Check the direction of rotation of fans and pumps and check the bearing lubrication. Check whole assembly for tightness, general appearance etc.

Oil leakage test.

Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.

Leakage checks on bushing before erection.

Measure and record the dew point of gas in the main tank before assembly.

4.37.0 Commissioning Checks

Check the colour of silicagel in silicagel breather. Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

Check the bushing for conformity of connection to the lines etc.

Check for correct operation of all protection devices and alarms/trip:

i. Buchholz relay

ii. Excessive winding temperature

iii. Excessive oil temperature

iv. Low oil flow

v. Low oil level indication

vi. Fan and pump failure protection

Check for the adequate protection on the electric circuit supplying the accessories.
Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:

i) Control wiring
ii) Cooling system motor and control
iii) Main windings
iv) Tap changer motor and control

Check for cleanliness of the transformer and the surroundings.

2 kV for 1-minute test between bushing CT terminal and earth.
Phase out and vector group test.
Ratio test on all taps.

Magnetising current test.
Capacitance and Tan delta measurement of winding and bushing.
Frequency response analysis (FRA). FRA equipment shall be arranged by purchaser.

DGA of oil just before commissioning and after 24 hours energisation at site.
Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

Continuously observe the transformer operation at no load for at least 24hours.
Contractor shall prepare a comprehensive commissioning report including all commissioning test results as per Pre-Commissioning Procedures forward to Purchaser for future record.

4.38.0 NITROGEN INJECTION TYPE FIRE PREVENTION & EXTINGUSHING SYSTEM

Nitrogen Injection Type Fire Protection System (NIFPS) shall be designed to prevent explosion of transformer tank and the fire during internal faults resulting from arc and also to extinguish the external oil fires on transformer due to tank explosion and/or external failures like bushing fires, OLTC fires and fire from surrounding equipments, etc.

The system shall work on the principle of Drain & stir. On activation, it shall drain a predetermined quantity of oil from the tank top through drain valve to reduce the tank pressure, isolate conservator tank oil and inject nitrogen gas at high pressure from the bottom side of the tank through inlet valves to create stirring action and reduce the temperature of oil below flash point to extinguish the fire. On operation, the quantity of oil removed from the tank shall be such that adequate amount of oil shall remain to cover active part (i.e., core coil assembly). Electrical isolation of transformer shall be an essential pre-condition for activating the system.

4.38.1.0 Operational Controls

The system operation shall be fully automatic and activate from the required fire and other trip signals. In addition to automatic operation, remote operation from control room/ remote centre and local manual control in the fire extinguishing cubicle shall also be provided. System shall operate on following situations:

4.38.1.1 Prevention of transformer from explosion and fire

To prevent transformer from explosion and fire in case of an internal fault, signals given by operation of Electrical protection relays and tripping of circuit breaker of transformer and operation of either Buchholz relay or pressure relief valve (PRV) shall be used to activate the system. The exact logic for system activation shall be finalized during detailed engineering.

4.38.1.2 Prevention of transformer from fire

In case of fire, sensed by fire detectors, the system shall be activated only after electrical isolation of the transformer, confirmed by breaker trip. If the fire detection is not associated with any other fault, the system activation shall be only manual. Manual operation switch shall be provided in the control room with a cover to avoid accidental operation of it.

4.38.2.0 Operation of System

On receiving activation signal, the following shall take place:

i) Open the quick opening drain valve to drain the top layer oil
ii) Shut off the conservator isolation valve to prevent flow of oil from the Conservator tank to the main tank
iii) Open the Nitrogen regulator valve to inject Nitrogen into the transformer tank to create stirring of oil.
There shall be interlock to prevent activation of the system if the transformer is not electrically isolated.
There shall also be provision for isolating the system during maintenance and/or testing of the transformer.

4.38.3.0 Technical Particulars

The contractor shall be responsible for the design of the complete system and shall submit the drawings and design calculations for the number of fire detectors, pipe sizing of drain pipe and Nitrogen injection pipe, Nitrogen cylinder capacity, number of injection points, etc. and get approval from AEGCL.
Facility shall be provided to test the system when the transformer is in service, without actually draining the oil and injecting Nitrogen.

The Nitrogen regulator valve shall be designed in such a way that the Nitrogen shall not enter the transformer tank even in case of passing/ leakage of valve.

Owner shall provide two distinct station auxiliary DC feeders for control purposes. The system shall work on station DC supply with voltage variation defined in Data Sheet. The control box of fire protection system shall have facility to receive these feeders for auto changeover of supply. It shall be the contractor’s responsibility to further distribute power to the required locations. In case auxiliary DC power supply requirement is different than station auxiliary DC supply, then all necessary DC-DC converters shall be provided by the Contractor.

Following minimum indications and alarms shall be provided in the local cubicle as well as in the control box:-

- Nitrogen cylinder pressure indication - manometer with sufficient number of adjustable NO contacts
- Nitrogen cylinder pressure low
- Fire in Transformer
- Oil drain started
- Conservator oil isolation valve closed
- Nitrogen injection started
- DC supply fail

- Oil drain valve closed
- Gas inlet valve closed

4.38.4.0 Details of Supply of System Equipment and Other Related Activities:

The scope of supply shall include the following items and any other items required for safe and trouble-free operation of the system.

i) Fire extinguishing cubicle with base frame and containing at least the following:
   - Nitrogen gas cylinder of sufficient capacity with pressure regulator and manometer with sufficient number of adjustable NO contacts.
   - Oil Drain Assembly including oil drain pipe extension of suitable size for connecting pipes to oil pit
   - Mechanical release device for oil drain and nitrogen release
   - Limit switches for monitoring of the systems
   - Panel lighting
   - Flanges on top of the panel for connecting oil drain and nitrogen injection pipes for transformer
   - Back up pressure switch to operate nitrogen gas valve
   - Pressure indicators for Nitrogen pressure of the cylinder and actual injection through Nitrogen regulator

ii) Control box to be installed in the control room of the station for monitoring system operation, automatic control and remote operation, with alarms, indications, switches, push buttons, audio signal, suitable for tripping and signalling.

iii) Required number of fire detectors to be located in strategic locations to be finalized during detailed engineering.

iv) All controls, alarms, panels, cables, cable trays (if required), junction boxes etc.

Detailed specification of Nitrogen Injection Type Fire Protection System (NIFPS) shall be as per **Annexure-R.**

4.39.0 Under Ground Oil Storage Tank

Each transformer unit shall be provided with an underground oil storage tank. The oil storage tank shall have non-Corrosive, water proof, epoxy coated (from Inside) mild steel (minimum thickness 6 mm) to store drained out oil on operation of NIFPS. The tank shall be painted from outside as per Clause 17.16.0. The total capacity of storage tank shall be at least 10% of transformer tank oil to avoid overflowing of oil considering that drained oil volume shall be around 10% of transformer tank oil. Necessary arrangement shall be made on underground storage tank so as to take out the drained oil from the tank for further processing and use. All the pipe and physical connection from transformer to oil pit shall be in the scope of contractor.

This storage tank shall be placed in the pit made of brick walls with PCC (1:2:4) flooring with suitable cover plates to avoid ingress of rain water. The design of tank and pit shall be finalized during detailed engineering. **All underground oil and gas storage tanks design shall be certified by petroleum and explosive safety organisation, Nagpur, India.**

4.39.1.1 Installation and pre-commissioning test

After installation the system pre-commissioning tests shall be carried out jointly with the Owner's representative before the system is put in service.

4.39.1.2 Online Insulating oil drying system

On-line insulating oil drying system (Cartridge type) along with all required accessories shall be provided with each transformer. In addition to provision of air cell in conservators for sealing of the oil system against the atmosphere, each transformer shall be provided with an on-line insulating oil drying system of adequate rating with proven field performance. This system shall be tank/cooler bank mounted and no separate foundation shall be provided. This on-line insulating oil drying system shall be

(i). Designed for very slow removal of moisture that may enter the oil system or generated during cellulose decomposition. Oil flow to the equipment shall be controlled through pump of suitable capacity.

(ii). The equipment shall display the moisture content in oil (PPM) of the inlet and outlet oil from the drying system. The moisture in inlet & outlet oil (PPM) shall have to be displayed in Local SCADA besides local HMI.

(iii). Minimum capacity of moisture extraction shall be 10 Litres before replacement of cartridge.
Calculation to prove the adequacy of sizing of the on-line insulating oil drying system along with make and model shall be submitted for approval of purchaser during detail engineering.

The equipment shall be supplied with Operation Manual (2 set for every unit), Software (if any), and Compact disc giving operation procedures of Maintenance Manual & Trouble shooting instructions.

Addition detailed specification of On-line insulating oil drying system shall be as per **Annexure-Q**

4.40.0 On Line Dissolved Hydrogen and Moisture Monitor

The Monitor shall be a microprocessor based Intelligent Electronic Device (IED), designed tocontinuously detect and measure dissolved Hydrogen and Water content, even at very lowconcentrations, in Transformer Oil. It should be easy to install and it should be possible to retrofit it on an energized transformer, without shutting down the transformer.

The monitor shall be designed for permanent outdoor use in high voltage sub-station environments, for ambient temperatures of 0 deg C to 55 deg C and oil temperatures of 5 deg C to 105 deg C.

The monitor shall be suitable to detect and measure dissolved Hydrogen in ppm, without significant interference from other fault and atmospheric gases. The monitor shall also be suitable to detect Water Content measured in ppm.

The Hydrogen sensors shall have long lifetime in oil. The sensors shall be able to withstand pressure from vacuum to 10 psi.

4.40.1.0 Technical Parameters:

Sr. No.	Parameters	Requirements

1	**The measurement range / Output:**	
	Hydrogen Dissolved in oil	0 to 2000 ppm, with 4 – 20 mA output
	Water Dissolved in oil	0 to 95% RS, with 4 – 20 mA output
2	**Alarms/Indication (High & Very High)**	
	Hydrogen	Programmable NO/NC contacts,
	Water	Programmable NO/NC contacts,
3	**Environment**	
	Operating Ambient Temperature	0 to + 55 deg C
	Operating Oil Temperature	5 to + 105 deg C
	Pressure Withstand, (Oil side)	Full Vacuum to 10 psi.
4	Exterior enclosure and components	made of corrosion proof material to IP - 55
5	Communications	RJ45/RS–232 ports and suitable for Ethernet connectivity

Addition detailed specification of On-Line Dissolved Hydrogen and Moisture Monitor shall be as per **Annexure-P**

4.41.0 Condition Controlled Maintenance Free Type Breather

The main Transformer tank conservator shall be fitted with a Maintenance-Free type silica gel Breather which shall be equipped with a humidity sensor, a condition-based microprocessor control unit and LED status indication.

4.41.1.0 Dehydrating breather's operating principle:

When the oil conservator breaths-in (e.g., at reduced load), the air flows through a filter made of high-grade steel wire mesh. The equipment fitted with filter & the dust cap, filters the dust, sand and other dirt particles from the air. The filtered air flows through the desiccant chamber filled with colourless, moisture absorbing pellets and are dehydrated. The dehydrated air rises further via the pipe in the oil conservator. The desiccant is dehydrated by the built-in heating unit which is controlled by sensors, thus obviating the need for periodic desiccant replacement. The dehydrating breather is mounted on the pipe to the oil conservator at a height of 1200 mm approximately from transformer rail top level.

4.41.1.1 Technical Features:

Material & External Construction of the Breather shall be such that all external parts are suitable for outdoor use & resistive to transformer oil, ultraviolet rays, pollution & salt water and shall work without any trouble for ambient temperature between 0^{o} C to $+80^{o}$ C.

Following LEDs for local display on control unit, and suitable contacts &analog signal shall be provided for wiring to remote location:

a. LED for Power of control unit - ON
b. LED for Filter heater- ON
c. LED for Anti-condensation heater (of control unit) - ON
d. LED & relay contact for "Device Error"

e. LED & relay contact for Regeneration active (De-humidification in process)
f. Analogue output signal (4-20mA) for the Temperature of air (in filter unit / pipe).

The Breather shall be equipped with test button which should allow to carry out a self-test and to check the functions like relay circuits, heating or the signal transmission in the control room, etc. at any time.

Control unit shall be equipped with a USB / RS 485 port for downloading the operational data logged by the unit. All necessary software required for downloading and analysing the logger data shall also be provided by the supplier. Supply of Laptop/PC for above software is not envisaged.

The moisture and temperature measurement system (sensor) installed should be modular making it easy to replace the same if at all the same is necessary during the service of breather.

The equipment shall operate at input supply of 230V AC, 50 Hz. Any converter if required shall be supplied with the equipment.

Degree of Protection shall be at least IP55 for which type Test report shall be submitted. Necessary protective devices shall be provided in order to protect the equipment against over voltages & high frequency interference.

The control unit shall be equipped with suitable heater to prevent moisture condensation.

The size of Condition controlled maintenance free dehydrating breather shall be decided based on the volume of transformer oil during detailed engineering.

For OLTC conservator, conventional breather shall be supplied as per technical specification.

Condition Controlled Maintenance Free Type Breather of alternate proven technology shall also be acceptable.

Addition detailed specification of Condition Controlled Maintenance Free Type Breather shall be as per **Annexure-U**

4.42.0 Automatic Mulsifire System (or High Velocity Water Spray System)

4.42.1.0 Description:

This system is widely used for fire fighting of outdoor transformers. Spray type fire protection essentially consists of a network of projectors and an array of heat detectors used to sense high temperature near the transformer to be protected. If the temperature exceeds the set value, the automatic mulsi fire system sprays water at high pressure through a Deluge valve from the pipe network laid for this system. Fire detectors located at various strategic points are on the surface of the transformer to control fire on any burning oil spilled over.

4.43.1.1 Subsystems used to make a complete mulsi fire system:

a) Main Hydrant

This is used to carry the water to various parts of the switchyard or transformer substation and forms the backbone of the system. Sturdy corrosion-free pipes and valves are used for this purpose. The materials should be able to with stand fire for areas on able duration.

b) Fire Detector

Fire detectors can either be thermocouples or specially designed bulbs which burst when they experience a high temperature and release any valves or checking device to start the water supply.

c) Ring Mains and Nozzles

Ring mains, which surround the transformer are provided to feed the water to the nozzles at various levels. Since the water pressure is high, the ring mains should be designed to withstand this pressure. Nozzles should be located such that the water spray, in the event of a fire, envelopes the entire surface of the transformer. The whole system should be periodically checked to detect any leakages.

d) Pumps

Pumps are provided to fill the hydrants initially and to maintain its pressure. Pumps driven by electrical motors are a standard provision; however, the standby pumps should preferably be diesel engine driven. It is recommended that the main and stand by pumps in a pump house be segregated.

4.43.1.2 Electrical Safety

As per IEEMA specification, from safety considerations, the following electrical clearances are recommended between the mulsifier system pipe work and live parts of the transformer to be protected.

- 420 kV bushing 3500mm
- 245 kV bushing 2150mm
- 145 kV bushing 1300mm
- 52 kV bushing 630mm
- 36 kV bushing 320mm

4.43.1.3 Installation Care

- Deluge Valve shall be water pressure operated manual reset type.
- Each Deluge valve shall be provided with a local panel from which will enable manual electrical operation of the valve.
- In addition to this, each valve shall be provided with local operation latch.
- Test valves shall simulate the operation of Deluge valves and shall be of quick opening type.

4.44.0 Transformer – Connection to GIS:

Transformer connection enclosure shall be part of gas insulated metal enclosed switchgear which shall house one end of a completely immersed bushing fitted on a power transformer and main circuit end terminal of GIS. The transformer connection enclosure shall be designed as per the recommendations of IEC 62271-211 and the limit of supply of switchgear manufacturer and the transformer manufacturer shall also be as per the scope mentioned in the IEC. The switchgear manufacturer shall supply connection between the enclosures of different phases as per requirement to limit the circulating current in the transformer tanks. The manufacturer of the connection enclosure shall take into account the total dynamic forces generated during short circuit and the enclosure as well as bushings shall be capable of withstanding vacuum during evacuation process. The switchgear manufacturer shall make necessary arrangement to limit the very fast front transient ground potential rises which may occur during switching operation. The detailed scope of transformer manufacturer and GIS manufacturer as per IEC 62271-211.

4.45.0 CENTRE OF GRAVITY:

The center of gravity of assembled transformer shall be as low and as near the vertical center line as possible. The transformer shall be stable with and without oil. The location of the center of gravity, relative to track shall be clearly marked in the outline drawing, accompanying bid.

Annexure – A 1.0

Technical Particulars / Parameters of Transformers

(500MVA [3 phase] 400/220/33 kV, Auto Transformer)

ClauseNo.	Description	Unit	TechnicalParameters
1.1	Rated Capacity		
	HV	MVA	500
	IV	MVA	500
	LV(Tertiary)	MVA	5MVA(Thermalloading)
1.2	Voltage ratio (LinetoLine)		400/220/33
1.3	VectorGroup(3-Phase)		YNaOd11
1.4	Single/ThreePhaseDesign		3(THREE)
1.5	ApplicableStandard		IEC60076/IS2026
1.6	Cooling		ONAN / ONAF / OFAF orONAN/ONAF/ODAF
1.7	Ratingatdifferent cooling	%	60 / 80 / 100
1.8	CoolerBank Arrangement		2X 50%
1.9	Frequency	Hz	50
1.10	Tap Changer (OLTC)		+10% to -10% in 1.25% steps oncommonendofserieswinding for400kVside voltagevariation
1.11	TypeofTransformer		ConstantOhmicimpedancetype (Refernote1)
1.12	Impedanceat75 DegC		
	HV–IV		
	Max.Voltagetap	%	10.3
	Principaltap	%	12.5
	Min.Voltagetap	%	15.4
	HV– LV		
	Principaltap(minimum)	%	60.0
	IV–LV		
	Principaltap(minimum)	%	45.0
1.13	Tolerance on Impedance (HV-IV)	%	As per IEC, unless specifiedotherwise

1.14	Service		Outdoor
1.15	Duty		Continuous
1.16	OverloadCapacity		IEC-60076-7
1.17	Temperature rise over 50 degC ambient Temp		
i)	Top oil measured by thermometer	^{O}C	45
ii)	Average winding measured by resistance Method	^{O}C	50
1.18	Windinghot spot riseoveryearly weightedtemperatureof 32^{O}C	^{O}C	61
1.19	Tank Hotspot Temperature	^{O}C	110
1.20	Maximum design ambient temperature	^{O}C	50
1.21	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	1300
	IV	kVp	950
	LV	kVp	250
	Neutral	kVp	95
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	1430
	IV	kVp	1045
	LV	kVp	275
iii)	Switching Impulse withstand Voltage		
	HV	kVp	1050
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	570
	IV	kVrms	395
	LV	kVrms	95
	Neutral	kVrms	38
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV		Graded
	IV		Graded
	LV		Uniform
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤ 0.5
1.22	Bushing		
i)	Rated voltage		
	HV	kV	420
	IV	kV	245

	LV	kV	52
	Neutral	kV	36
ii)	Rated current (Min.)		
	HV	A	1250
	IV	A	2000
	LV	A	3150
	Neutral	A	2000
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1425
	IV	kVp	1050
	LV	kVp	250
	Neutral	kVp	170
iv)	Switching Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	695
	IV	kVrms	505
	LV	kVrms	105
	Neutral	kVrms	77
vi)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	mm	13020
	IV	mm	7595
	LV	mm	1612
	Neutral	mm	1116
	Neutral		
vii)	Max Partial discharge level at Um		
	HV	pC	10
	IV	pC	10
	LV	pC	10
	Neutral		-
1.23	Max Partial discharge level at 1.58 * Ur / √3	pC	100
1.24	Max Noise level at rated voltage and at principal tap at no load and all cooling active	dB	80
1.25	**Maximum Permissible Losses of Transformers**		500MVA
i)	Max. No Load Loss at rated voltage and frequency	kW	90

ii)	Max.Load Loss between HV & LV at Rated current and frequency and at75^{O}C	kW	500
iii)	Max. I^{2}RLoss at rated current at 75^{O}C	kW	375
iv)	Max.Auxiliary Loss at rated voltage and frequency	kW	15

Notes:

1. For parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**
5. External minimum clearances in air for Phase to Phase and Phase to Earth shall be provided as per IS 2026 (Part 3)/IEC60076-3

Annexure – A 2.0

1.0 Technical Particulars / Parameters of Transformers

(220/132/33 kV 160 MVA & 200 MVA 3-Phase Auto Transformer)

Cl.No.	Description	Unit	TECHNICALPARAMETERS	
4.1	Rated Capacity			
	HV	MVA	200	160
	LV	MVA	200	160
4.2	Voltageratio	kV	220/132	
4.3	Single/ThreePhaseDesign		Three	
4.4	VectorGroup(3-Phase)		YNaO	
4.5	ApplicableStandard		IEC60076/IS2026	
4.6	Cooling		ONAN / ONAF / OFAF orONAN/ONAF/ODAF	
4.7	Ratingatdifferent cooling	%	60 / 80 / 100	
4.8	CoolerBank Arrangement		2X 50%	
4.9	Frequency	Hz	50	
4.10	Tapchanger			
i)	Type		OLTC	
ii)	TapRange&steps		–5%to +15%in steps of 1.25%for132 kV variation	
iii)	LocationofTapchanger		Onthe132 kV lineend	
4.11	HV-LVImpedanceat75 DegC			
i)	Max.Voltagetap	%	9.5	
ii)	Principaltap	%	12.5	

iii)	Min.Voltagetap	%	14
iv)	ToleranceonImpedance	%	AsperIEC
4.12	Service		OUTDOOR
4.13	Duty		CONTINUOUS
4.14	OverloadCapacity		IEC60076-7
4.15	Temperatureriseover 50degCAmbient Temp		
i)	Topoil measured bythermometer	^{O}C	45
ii)	Averagewindingmeasuredbyresistance Method	^{O}C	50
4.16	Windinghot spot riseoveryearly weightedtemperatureof32° C	^{O}C	61
4.17	TankHotspotTemperature	^{O}C	110
4.18	Maximumdesignambienttemperature	^{O}C	50
4.19	Windings		
i)	LightningImpulsewithstandVoltage		
	HV	kVp	950
	LV	kVp	650
	Neutral	kVp	95
ii)	SwitchingImpulsewithstandVoltage		
	HV	kVp	750
iii)	OneMinutePowerFrequencywithstand Voltage		
	HV	kVrms	395
	LV	kVrms	275
	Neutral	kVrms	38
iv)	NeutralGrounding		Solidlygrounded
v)	Insulation		
	HV		GRADED
	LV		GRADED
vi)	Tandeltaofwinding	%	≤0.5%
4.20	Bushings		
i)	Ratedvoltage		
	HV	kV	245
	LV	kV	145
	Neutral	kV	36
ii)	Ratedcurrent(Min.)		
	HV	A	1250
	LV	A	1250
	Neutral	A	2000
iii)	LightningImpulsewithstandVoltage		
	HV	kVp	1050

	LV	kVp	650	
	Neutral	kVp	170	
iv)	SwitchingImpulsewithstandVoltage			
	HV	kVp	850	
v)	OneMinutePowerFrequencywithstand Voltage			
	HV	kVrms	505	
	LV	kVrms	305	
	Neutral	kVrms	77	
vi)	Minimumtotalcreepagedistances		(Specific creepage distance:31mm/kV corresponding to theline-to-linehighest system voltage)	
	HV	mm	7595	
	LV	mm	4495	
	Neutral	mm	1116	
viii)	MaxPartialdischargelevelat U_m			
	HV	pC	10	
	LV	pC	10	
4.21	Max Partialdischargelevelat1.5Um/√3	pC	100	
4.22	Max Noise level at rated voltage, principal tap&noloadandallcoolingactive	dB	75	
4.23	**Maximum Permissible Losses ofTransformers**		200MVA	160MVA
i)	Max.No Load Loss at rated voltage and Frequency	kW	35	30
ii)	Max. Load Loss between HV & LV at rated current and frequency and at 75^{O}C	kW	260	200
iii)	Max. I^2RLoss at rated current at 75^{O}C	kW	190	145
iv)	Max.Auxiliary Loss at rated voltage and frequency	kW	8	6

Notes:

1. For parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**
5. External minimum clearances in air for Phase to Phase and Phase to Earth shall be provided as per IS 2026 (Part 3)/IEC60076-3

Annexure – A 3.0
Technical Particulars/Parameters
(132/33 KV, 3-Phase Transformer)

S.No.	Description	Unit	TECHNICALPARAMETERS		
7.1	Voltage ratio(Line-to-Line)	kV	132/33		
7.2	Rated capacity(HV andLV)	MVA	80	50	31.5
7.3	No of phases		3(Three)		
7.4	Vector Group		YNynO		
7.5	Type of transformer		PowerTransformer		
7.6	Applicable Standard		IEC60076/ IS2026		
7.7	Cooling type		ONAN/ONAF		
7.8	Rating at different cooling	%	60 / 100		
7.9	Cooler Bank Arrangement		1X 100%		
7.10	Frequency	Hz	50		
7.11	Tapchanger				
i)	Type		On-load tap changer (CFVV)		
ii)	Tapping range and steps		-15%to +5%in stepsof1.25%for HVvariation		
iii)	Location of tap changer		OnHVneutralend		
7.12	HV-LV Impedance at 75°C, at Highest MVA base				
i)	Max.Voltage tap	%	13.2		
ii)	Principal tap	%	12.5		
iii)	Min.Voltage tap	%	11.8		
7.13	Tolerance on Impedance	%	AsperIEC		
7.14	Service		Outdoor		
7.15	Duty		Continuous		
7.16	Overload Capacity		IEC60076-7		
7.17	Temperature rise over 50°C ambient temp.				
i)	Top oil measured by thermometer	^{O}C	45		
ii)	Average winding measured by Resistance method	^{O}C	50		
7.18	Winding hot spot rise over yearly weighted temperature of 32^{O}C		61		

7.19	Tank hotspot temperature		110
7.20	Maximum design ambient temperature	^{O}C	50
7.21	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	650
	LV	kVp	170
	HV Neutral	kVp	95
	LV Neutral	kVp	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	715
	LV	kVp	187
iii)	Switching Impulse withstand Voltage		
	HV	kVp	540
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	275
	LV	kVrms	70
	HV Neutral	kVp	38
	LV Neutral	kVp	70
v)	Neutral Grounding (HV and LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤0.5%
7.22	Bushings		
i)	Rated voltage		
	HV	kV	145
	LV, LV Neutral & HV Neutral	kV	36
ii)	Rated current (Min.)		
	HV	A	1250
	LV	A	1250 for (50 & 31.5MVA) 2000 (for 80MVA)
	HV Neutral & LV Neutral	A	1250
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	650

	LV, HV Neutral and LV Neutral	kVp	170		
iv)	One Minute Power Frequency withstand Voltage				
	HV	kVrms	305		
	LV, HV Neutral and LV Neutral	kVrms	77		
v)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)		
	HV	Mm	4495		
	LV, HV Neutral and LV Neutral	Mm	1116		
vi)	Max Partial discharge level at Um on HV	pC	10		
7.23	Max Partial discharge level at 1.58*Ur/√3	pC	100		
7.24	Max Noise level at rated voltage, principal tap & no load and all cooling active	dB	75 for 80MVA & 50MVA 70 for 31.5MVA		
7.25	**Maximum Permissible Losses of Transformers**		**80 MVA**	**50 MVA**	**31.5 MVA**
i)	**Max. No Load Loss at rated voltage and frequency**	kW	**35**	**25**	**18**
ii)	**Max. Load Loss at rated current and frequency and at 75O C at principal tap between HV & LV**	kW	**200**	**125**	**110**
iii)	**Max. I2R Loss at rated current and frequency and at 75O C at principal tap between HV & LV**	kW	**170**	**105**	**93.5**
iv)	**Max. Auxiliary Loss at rated voltage and frequency**	kW	**5**	**3**	**2**

Notes:

1. For parallel operation with existing transformer, percentage impedance, OLTC connection & range, vector group and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**
5. External minimum clearances in air for Phase to Phase and Phase to Earth shall be provided as per IS 2026 (Part 3)/IEC60076-3

Annexure – A 4.0

Technical Particulars/Parameters
(220/33 KV, 100 MVA 3-Phase Transformer)

Cl.No.	Description	Unit	TechnicalParameters
6.1	Voltage ratio (Line-to-Line)	kV	220/33
6.2	Rated Capacity		
	HV	MVA	100
	LV	MVA	100
6.3	No o fphases		3(Three)
6.4	VectorGroup		YNyn0
6.5	Type of transformer		Powertransformer
6.6	Applicable Standard		IEC60076/ IS2026
6.7	Cooling type		ONAN/ONAF/OFAForONAN/O NAF/ODAF
6.8	Rating at different cooling	%	60 / 80 / 100
6.9	Frequency	Hz	50
6.10	Cooler Bank Arrangement		2X 50%
6.11	Tap Changer		
i)	Type		On-loadtapchanger
ii)	Tap range and steps		-15%to +5%insteps of1.25% forHVvariation
iii)	Location of tap changer		OnHVneutralend
6.12	Impedanceat75°C, at highest MVA Base		
i)	Max.Voltage tap	%	16.2
ii)	Principal tap	%	15.0
iii)	Min.Voltage tap	%	14.0
iv)	Tolerance on Impedance		AsperIEC
6.13	Service		Outdoor
6.14	Duty		Continuous
6.15	Overload Capacity		IEC-60076-7
6.16	Temperature rises over 50 degC ambient Temp		
i)	Top oil measured by thermometer	^{O}C	45
ii)	Average winding measured by Resistance method	^{O}C	50
6.17	Windinghot spot rise over yearly weighted temperature of 32^{O}C	^{O}C	61
6.18	Tank Hotspot Temperature	^{O}C	110
6.19	Maximum design ambient temperature	^{O}C	50
6.20	Windings		

i)	Lightning Impulse withstand Voltage		
	HV	kVp	950
	LV	kVp	170
	HVNeutral	kVp	95
	LVneutral	kVp	170
ii)	ChoppedWaveLightningImpulse WithstandVoltage		
	HV	kVp	1045
	LV	kVp	187
iii)	SwitchingImpulsewithstandVoltage		
	HV	kVp	750
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	395
	LV	kVrms	70
	HV Neutral	kVrms	38
	LV neutral		70
v)	Neutral Grounding (HV & LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤ 0.5
6.21	Bushing		
i)	Rated voltage		
	HV	kV	245
	LV	kV	36
	HV Neutral	kV	36
	LV Neutral		
ii)	Rated current		
	HV	A	1250
	LV	A	3150
	HV Neutral	A	3150
	LV neutral		3150
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1050
	LV	kVp	170
	HV Neutral	kVp	170
	LV neutral	kVp	170
iv)	Switching Impulse withstand Voltage		
	HV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	505

	LV	kVrms	77
	Neutral	kVrms	77
vi)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV bushing	mm	7595
	LV bushing	mm	1116
	HV neutral / LV neutral	mm	1116
vii)	Max Partial discharge level at Um		
	HV	pC	10
6.22	Max Partial discharge level at 1.58 * Ur / √3	pC	100
6.23	Max Noise level at rated voltage, principal tap & no load and all cooling active	dB	80
6.24	**Maximum Permissible Losses of Transformers**		
i)	Max. No Load Loss at rated voltage and frequency	kW	43
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	245
iii)	Max. I2R Loss at rated current and at 75° C for HV and LV windings at principal tap position	kW	200
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	5

Notes:

1. For parallel operation with existing transformer, percentage impedance, OLTC connection & range, vector group and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**
5. External minimum clearances in air for Phase to Phase and Phase to Earth shall be provided as per IS 2026 (Part 3)/IEC60076-3

Annexure–B

Design Review Document

Sr. No.	Description

1.	Core and Magnetic Design
2.	Over-fluxing characteristics upto 1.7U_m
3.	Inrush-current characteristics while charging from HV & IV respectively.
4.	Winding and tapping design
5.	Short-circuit withstand capability including thermal stress for min. 2 Sec.
6.	Thermal design including review of localised potentially hot area.
7.	Cooling design
8.	Overload capability
9.	Eddy current losses
10.	Seismic design, as applicable
11.	Insulation co-ordination
12.	Tank and accessories
13.	Bushings
14.	Tap changers
15.	Protective devices
16.	Fans, pumps and radiators
17.	Sensors and protective devices– its location, fitment, securing and level of redundancy
18.	Oil and oil preservation system
19.	Corrosion protection
20.	Electrical and physical Interfaces with substation
21.	Earthing (Internal & External)
22.	Processing and assembly
23.	Testing capabilities
24.	Inspection and test plan
25.	Transport and storage
26.	Sensitivity of design to specified parameters
27.	Acoustic Noise
28.	Spares, inter-changeability and standardization
29.	Maintainability
30.	PRD and SPR (number & locations)
31.	Conservator capacity calculation
32.	Winding Clamping arrangement details with provisions for taking it “in or out of tank”
33.	Conductor insulation paper details
34.	The design of all current connections
35.	Location & size of the Valves

Annexure-C

UNDERTAKING

We, M/s. ------------------------- , have participated in Tender No. ---------------------- for supply of:

1) -------- kV class -------- MVA Auto/Power Transformers
2) -------- kV class -------- MVA Auto/Power Transformers
3) -------- kV class -------- MVA Auto/Power Transformers
4) -------- kV class -------- MVA Auto/Power Transformers

to AEGCL.

In accordance with the terms of the said tender, we hereby undertake that we shall use imported prime CRGO steel lamination and not the second grade CRGO steel lamination for the manufacturing of the transformers against this Tender. Further, we shall produce the following documents at the time of inspection of transformers:

a) Invoice of supplier
b) Mill's Test Certificate issued by Customs
c) Packing list
d) Bill of lading
e) Bill of entry Certificate issued by Customs.

Signature of the Tenderer :
Name :
Designation :
Seal of the Company :

(On Rs 100/- stamp paper duly notarized

Annexure – D
Painting Procedure

PAINTING	**Surface preparation**	**Primer coat**	**Intermediate undercoat**	**Finish coat**	**Total dry film thick-ness (DFT)**	**Colour shade**
Main tank, pipes conservator tank oil storage tank & DM Box etc. (external surfaces)	Shot Blast cleaning Sa 2½*	Epoxy base Zinc primer (30-40µm)	Epoxy high Micaceous iron oxide (HB MIO) (75µm)	Aliphatic build polyurethane (PU) (Minimum50µm)	Minimum155 µm	RAL 7035
Main tank, pipes (above80 NB), conservator tank, oil	Shot Blast cleaning	Hot oil proof, low viscosity varnish or Hot	--	--	Minimum 30µm	Glossy white for paint

storage tank& DM Box etc. (Internal surfaces)	Sa 2½*	oil resistance, non corrosive paint				
Radiator (external surfaces)	Chemical / Shot Blast cleaning Sa 2½*	Epoxy base Zinc primer(30-40μm)	Epoxy base Zinc primer (30-40μm)	PU paint (Minimum50μm)	Minimum100 μm	Matching shade of tank/different shade aesthetically matching to tank
	contractor may also offer Radiators with hot dip galvanised in place of					
	painting with minimum thickness of 40μm (min)					
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish or Hot oil resistant, non- corrosive Paint	--	--	--	--
Digital RTCC Panel Control cabinet	Seven tank process as per IS:3618 & IS:6005	Zinc chromate Primer (two coats) / Marshalling Box - No painting is required.	--	EPOXY paint with PU top coat or POWDER coated	Minimum80μm / for Powder Coated Minimum 100μm	RAL 7035 shade for exterior and Glossy white for interior
Note: (*)	Indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1.					

Annexure– E

UNUSEDINHIBITEDHIGHGRADEINSULATINGOILPARAMETERS

Sl. No.	Property	Test Method	Limits
A	**Function**		
1a.	Viscosity at 40 degC	IS1448 Part25 o rISO3104 or ASTM D7042	(Max.)12mm²/s
1b.	Viscosity at-30 deg C		(Max.)1800mm²/s
2.	Appearance	A representative sample of theoil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent, and free from suspendedmatter or sediment

3.	Pour point	IS1448 Part10/Sec2 or ISO 3016	(Max.)-40degC
4.	Water content a) For bulk supply b) For delivery in drums	IEC 60814	(Max.)30mg/kg40mg/kg
5.	Electric strength (breakdown voltage)	IS 6792 or IEC 60156	(Min.) 50kV (new unfiltered oil) /70kV(aftertreatment)
6.	Density at 20 degC	IS1448 Part 16 or ISO12185 or ISO3675 or ASTM D7042	Max 0.895g/ml
7.	Dielectric dissipation Factor (tan delta) at 90 degC	IS16086 or IEC60247 or IEC61620	(Max) 0.0025
8.	Negative impulse testing KVp @25 deg C	ASTMD-3300	145 (Min.)
B	**Refining/Stability**		
1.	Colour	ISO2049	L0.5(lessthan0.5)
2.	Acidity	IEC 62021-2 or 62021-1	(Max)0.01mgKOH/g
3.	Interfacial tension at 27 deg C	IEC 62961 or ASTM D971	0.043N/m(min)
4.	Total sulphur content	ISO 14596 or ISO 8754	0.05 % (Max.) (beforeoxidationtest)
5.	Corrosivesulphur	DIN51353	Not-Corrosive
6.	Potentially corrosive sulphur	IEC 62535	Not-Corrosive
7.	DBDS	IEC62697-1	Notdetectable(<5mg/kg)
8.	Presence of oxidationinhibitor	IS 13631 or IEC60666	0.08%(Min.) to 0.4%(Max.) Oil should contain no other additives. Supplier should declare presence of additives, if any.
9.	Metal passivat or additives	IEC60666	Not detectable(<5mg/kg)
10.	2-Furfural content and related compound content	IS 15668 or IEC 61198	Not detectable (<0.05 mg/kg) for each individual compound
C	**Performance**		
1.	Oxidationstability	IEC 61125 (method c) Test duration500hour	
2.	Totalacidity*	4.8.4 of IEC61125:2018	0.3mgKOH/g(Max.)
3.	Sludge*	4.8.1 of IEC61125:2018	0.05 %(Max.)
4.	Dielectricdissipationfactor(tandelta) at 90degC	4.8.5 of IEC61125:2018	0.05(Max.)
	*Valuesattheendofoxidationstabilitytest		
D	**Health, safety and environment (HSE)**		

1.	Flashpoint	IS1448Part21or ISO2719	(Min.)135degC
2.	PCAcontent	IP346	< 3%
3.	PCBcontent	IS 16082 or IEC61619	Not detectable (< 2mg/kg)
E	**Oil used (inhibited) for first filling, testing and impregnation of active parts at manufacturer's works shall meet parameters as mentioned below:**		
1	Break Down voltage (BDV)		70kV(min.)
2	Moisture content		5ppm(max.)
3	Tan-delta at 90°C		0.005(max)
4	Interfacial tension		0.04N/m(min)
F	**Each lot of the oil shall be tested prior to filling in maintan k at site for the following:**		
1	Break Down voltage (BDV)		70kV (min.)
2	Moisture content		5ppm(max.)
3	Tan-delta at 90°C		0.0025(Max)
4	Interfacialtension		0.04N/m(min)
G	**After filtration & settling and prior to energisation at site oil shall be tested for following:**		
1	Break Down voltage (BDV)		70kV (min.)
2	Moisture content at hot condition		5ppm(max.)
3	Tan-delta at 90°C		0.005(Max)
4	Interfacial tension		Morethan 0.04 N/m
5	*Oxidation Stability		
	a) Acidity		0.3(mgKOH/g) (max.)
	b) Sludge		0.05 %(max.)
	c)Tan deltaat90°C		0.05(max.)
6	*Total PCB content		Not detectable (less than 2mg/kg total)
*Separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning For approval of AEGCL.			

Note: Supplier shall declare the chemical family and function of all additives and the concentrations in the cases of inhibitors, antioxidants and passivators.

Annexure- F

RATING & DIAGRAM PLATE

The transformer shall be provided with a rating plate of weather proof material, fitted in a visible position, showing the appropriate items indicated below. The entries on the plate shall be in English and leglibly marked.

Minimum Information to be provided on the plate:

Manufacturer's name, country, and city where the transformer was assembled				
MVA Rating, Voltage ratio, Type of transformer(forexample315MVA400/220/33kVAutoTransformer)				
TypeofCooling			ApplicableStandard	
Rated Power atdifferentcooling			Ratedfrequency	Hz
HV/IV	MVA	--/--/--	Numberofphases	
LV	MVA		%Impedance/OhmicImpedance	
RatedVoltage			(a)HV-IV	
HV	kV		Min.tap	%
IV	kV		PrincipalTap	%
LV	kV		Max.Tap	%
RatedCurrent			(b) HV-LV	%
HV	A		(c)IV-LV	%
IV	A		VectorGroup	
LV	A		Coremass	kg
Rated ThermalShortCircuitwithstand	Ka(sec)		CopperMass	
Capability Current and Duration				
Basic Insulation Level (Lightening Impulse/Switching Impulse/Power Frequency Withstand Voltage)			(a) HV	Kg
HV	kVp/kVp/ kVrms		(b) IV	Kg
IV	kVp/ Vp/ kVrms		(c) LV	Kg
LV	kVp/kVp/ kVrms		(d) Regulating	Kg
Neutral	kVp/kVp/ kVrms		Core & Coil Mass	Kg
Guaranteed Temperature rise over ambient temperature of 50 Deg. C			Transportation Mass	Kg
(a) Top Oil	0C		Tank & Fitting mass	
(b) Winding	0C		Type & total mass of insulating oil	Kg

Vacuum withstand Capability of the tank	mm of Hg		Total mass	Kg
OLTC make and rating (current& Voltage class)			Quantity of oil in OLTC	Ltrs
Noise level at rated voltage and at principal tap	dB		Transformer oil Quantity	Ltrs
Tan delta of winding			Paint Shade	
Moisture content	ppm		No loadloss at rated voltage & frequency	KW
Manufacturer's Serial number			Load loss at rated current & frequency (at 75^{0}C) for HV & IV/LVwinding	KW
Year of manufacture			I^2R loss at rated current & frequency (at 75^{0}C) for HV&IV/LV winding	KW
Work Order No.			Auxiliary loss at rated voltage & frequency	KW
Purchaser's Order No.& Date				
OGA Drg.No.				
VectorGroupDiagram				
WindingConnectiondiagram (Connection between all windings including tap windings, ratings of built-in current transformers, etc. shall be presented on the diagram)				
Table giving details of OLTC like tap position Nos. and corresponding tapping voltage, tapping current & connection between terminals for different tap positions etc.				
Details of Current Transformers (e.g. Bushing CTs, CT for WTI) installed in transformer like the location, core Nos., ratio(s), accuracy class, rated output (VAburden), knee point voltage, magnetizing current, maximumCT secondary resistance, terminal marking and application of the currenttransformer				
Warning: "Mainconservatorisfittedwithanaircell"				
Tie-in-resistor has been used in OLTC (if applicable)				
Purchaser'sName				

When a transformer is intended for installation at high altitude, thealtitude, power rating and temperature rise at that altitude shall beindicatedonthenameplate.

Plates with identification and characteristics of auxiliary equipmentaccording to standards for such components (bushings, tap-changers, current transformers, cooling equipment etc.) shall be provided on thecomponentsthemselves.

Annexure- G

1.0 Bushing Current Transformer and Neutral Current Transformer Parameters (On each phase) for 3-ph, 500MVA 400/220/33 kV Transformers:

Description	Bushing Current Transformer Parameters (Transformer)		
	HV Side	IV Side	Neutral Side
Ratio			
CORE 1	1600/1	1600/1	1600/1
CORE 2	1000/1	1600/1	-
CORE 3	Refer to note 1		
Minimum knee point voltage or burden and accuracy class			
CORE 1	1600V, PX / PS	1600V, PX / PS	1600V, PX / PS
CORE 2	0.2S Class 20VA ISF≤5	0.2S Class 20VA ISF≤5	-
CORE 3	Refer to note 1		
Maximum CT Secondary Resistance			
CORE 1	4.0 Ohm	4.0 Ohm	4.0 Ohm
CORE 2	-	-	-
CORE 3	Refer to note 1		
Application			
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault
CORE 2	Metering	Metering	-
CORE 3	Refer to note 1		
Maximum magnetization current (at knee point voltage)			
CORE 1	25 mA	25 mA	25 mA
CORE 2	-	-	-
CORE 3	Refer to note 1		

Note:

i) **Parameters of WTI CT for each winding shall be provided by the contractor.**
ii) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.
iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

2.0 Technical Parameters of Bushing Current Transformers and Neutral Current Transformers for 160MVA 220/132 kV 3-Ph Transformers:

Description	Bushing Current Transformer Parameters (Transformer)		
	HV Side	**IV Side**	**Neutral Side**
(a) Ratio			
CORE 1	1000/1	1000/1	1000/1
CORE 2	600/1	1000/1	-
CORE 3	Refer to note 1		
(b) Minimum knee point voltage or burden and accuracy class			
CORE 1	600V, PX / PS	600V, PX / PS	600V, PX / PS
CORE 2	0.2S Class15VA ISF ≤ 5	0.2S Class15VA ISF ≤ 5	-
CORE 3	Refer to note 1		
(c) Maximum CT Secondary Resistance			
CORE 1	1.5 Ohm	1.5 Ohm	1.5 Ohm
CORE 2	-	-	-
CORE 3	Refer to note 1		
(d) Application			
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault
CORE 2	Metering	Metering	-
CORE 3	Refer to note 1		
(e) Maximum magnetization current (at knee point voltage)			
CORE 1	100 mA	100 mA	100 mA
CORE 2	-	-	-
CORE 3	Refer to note 1		

NOTE:

i) **Parameters of WTI CT for each winding shall be provided by the contractor.**
ii) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.
iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

3 Technical Parameters of Bushing Current Transformer and Neutral Current Transformer for 50 MVA 132/33 kV 3-Ph Transformers:

Description	Bushing Current Transformer Parameters (Transformer)			
	HV Side	**HV Neutral Side**	**LV Side**	**LV Neutral Side**
(a) Ratio				
CORE 1	300/1	300/1	1000/1	1000/1
CORE 2	300/1	300/1	1000/1	1000/1

CORE 3	Refer to note 1			
(b)Minimum	**knee point voltage or burden and accuracy class**			
CORE 1 CORE 2	600V, PX / PS 0.2S Class 15VA ISF ≤ 5	600V, PX / PS 600V, PX / PS	1000V, PX / PS 0.2S Class 15VA ISF ≤ 5	1000V, PX / PS 1000V, PX / PS
CORE 3	Refer to note 1			
(c)Maximum	**CT Secondary**	**Resistance**		
CORE 1 CORE 2	1.5 Ohm -	1.5 Ohm 1.5 Ohm	1.5 Ohm -	1.5 Ohm 1.5 Ohm
CORE 3	Refer to note 1			
(d) Application				
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault
CORE 2	Metering	Restricted Earth fault	Metering	Restricted Earth Fault
CORE 3	Refer to note 1			
(e)Maximum	**magnetization**	**current (at knee**	**point voltage)**	
CORE 1 CORE 2	100 mA -	100 mA 100 mA	100 mA -	100 mA 100 mA
CORE 3	Refer to note 1			

NOTE:

i) Parameters of WTI CT for each winding shall be provided by the contractor.

ii) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.

iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

5.0 Technical Parameters of Bushing Current Transformer and Neutral Current Transformer for 100 MVA 220/33 kV 3-Ph Transformers:

Description	**Bushing Current Transformer Parameters (Transformer)**			
	HV Side	**HV Neutral Side**	**LV Side**	**LV Neutral Side**

(a) Ratio				
CORE 1	300/1	300/1	2000/1	2000/1
CORE 2	300/1	300/1	2000/1	2000/1
CORE 3	Refer to note 1			
(b)Minimum knee point voltage or burden and accuracy class				
CORE 1	600V, PX / PS	600V, PX / PS	2000V, PX / PS	2000V, PX / PS
CORE 2	0.2S Class 15VA ISF ≤ 5	600V, PX / PS	0.2S Class 15VA ISF ≤ 5	2000V, PX / PS
CORE 3	Refer to note 1			
(c)Maximum CT Secondary Resistance				
CORE 1	1.5 Ohm	1.5 Ohm	1.5 Ohm	1.5 Ohm
CORE 2	-	1.5 Ohm	-	1.5 Ohm
CORE 3	Refer to note 1			
(d) Application				
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault	Restricted Earth Fault
CORE 2	Metering	Restricted Earth Fault	Metering Fault	Restricted Earth Fault
CORE 3	Refer to note 1			
(e)Maximum magnetization current (at knee point voltage)				
CORE 1	100 mA	100 mA	100 mA	100 mA
CORE 2	-	100 mA	-	100 mA
CORE 3	Refer to note 1			

NOTE:

(i) **Parameters of WTI CT for each winding shall be provided by the contractor.**

(ii) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.

(iii) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

Annexure- H

Test Procedures

General

Tests shall be carried out as per following procedure. However, IEC 60076 shall be followed in general for other tests. Manufacturer shall offer the transformer unit for type testing with all major fittings including radiator bank, Marshalling Box, Common Marshalling Box RTCC (as applicable) assembled.

1. Core assembly dielectric and earthing continuitytest

After assembly each core shall be tested for 1 minute at 2000 Volts between all yoke clamps, side plates and structural steel work (core to frame, frame to tank & core to tank).

The insulation of core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank shall be able to withstand a voltage of 2 kV (DC) for 1 minute. Insulation resistance shall be minimum 1 GΩ for all cases mentioned above.

2. Measurement of windingresistance

After the transformer has been under liquid without excitation for at least 3 hr, the average liquid temperature shall be determined and the temperature of the winding shall be deemed to be the same as the average liquid temperature. The average liquid temperature is taken as the mean of the top and bottom liquid temperatures. Measurement of all the windings including compensating (in case terminal is available at outside) at normal and extreme taps.

In measuring the cold resistance for the purpose of temperature-rise determination, special efforts shall be made to determine the average winding temperature accurately. Thus, the difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by apump.

3. No-load loss and currentmeasurement

As per IEC 60076-1:2011 clause 11.5

4. Measurement of short-circuit impedance and loadloss

The short-circuit impedance and load loss for a pair of windings shall be measured at rated current & frequency with voltage applied to the terminals of one winding, with the terminals of the other winding short-circuited, and with possible other windings open- circuited. The difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump. Loss measurement for all combinations (HV-IV, HV-LV, IV-LV and at Normal and extremetaps).

5. Short term heat run test (Not Applicable for unit on which temperature rise test is performed)

In addition to the type test for temperature rise conducted on one unit, each cooling combination shall routinely be subjected to a short-term heat run test to confirm the performance of the cooling system and the absence of manufacturing defect such as major oil flow leaks that may bypass the windings orcore. DGA samples shall be taken at intervals to confirm the gas evolution.

For ODAF or OFAF cooling, the short-term heat run test shall be done with the minimum number of pumps for full load operation in order to shorten the temperature build up. Each short-term heat run test is nevertheless expected to take about 3 hours.

For ODAF or OFAF cooled transformers an appropriate cross check shall be performed to prove the effective oil flow through the windings. For this purpose, the effect on the temperature decay by switching the pumps off/ on at the end of the heat run should demonstrate the effectiveness of the additional oil flow. Refer to SC 12, 1984 CIGRE 1984 SC12-13 paper by Dam, Felber, Preiniger et al.

Short term heat run test may be carried out with the following sequence:

- Heat run test with pumps running but oil not throughcoolers.
- Raise temperature to 5 deg less than the value measured during temperature rise test.
- Stop power input and pumps for 6 minutes and observe cooling downtrend
- Restart pumps and observe increased cooling trend due to forced oilflow

This test is applicable for the Transformer without Pump also (ONAN or ONAF rating). Forsuchtypeoftransformertestmaybecarriedoutwiththefollowingsequence:

Arrangement shall be required with pump of suitable capacity (considering the oil velocity) without cooler bank. Raise the oil temperature 20-25 deg C above ambient. Stop power input and pumps for 6 minutes and observe cooling down trend. Restart pumps and observe increased cooling trend due to forced oilflow.

6. Temp. Rise Test as per IEC:60076

Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC60567.

The temperature rise test shall be conducted at a tap for the worst combination of loading (3-Winding Loss) for the Top oil of the transformer.

3-Winding Loss = HV (Max MVA) + IV (Max MVA) + LV (MaxMVA).
The Contractor before carrying out such test shall submit detailed calculations showing losses on various taps and for the three types of ratings of the transformer and shall recommend the combination that results in highest temperature rise for thetest.
The Temperature rise type test results shall serve as a “finger print” for the units to be tested only with short term heat runtest.
Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC60567.

Oil sample shall be drawn before and after heat run test and shall be tested for dissolved gas analysis. Oil sampling to be done 2 hours prior to commencement of temperature rise test. Keep the pumps running for 2 hours before and after the heat run test. Take oil samples during this period. For ONAN/ONAF cooled transformers, sample shall not be taken earlier than 2 hours after shut down. The acceptance norms with reference to various gas generation rates shall be as per IEC61181.

The DGA results shall generally conform to IEC/IEEE/CIGRE guidelines.

i. Test conditions for temperature risetest:

- This test shall be generally carried out in accordance with IEC60076-2
- For each cooling combination with cooler bank, tests shall be done on the maximum current tap for a minimum of 12 hours for ONAN/ONAF and 24 hours for ODAF or OFAF or ONAF2 with saturated temperature for at

least 4 hours while the appropriate power and current for core and load losses are supplied.

- The total testing time, including ONAN heating up period, steady period and winding resistance measurements is expected to be about 48 hours.
- DGA tests shall be performed before and after heat run test and DGA results shall generally conform to IEC/IEEE/CIGREguidelines.

ii. Testrecords:

Full details of the test arrangements, procedures and conditions shall be furnished with the test certificates and shall include atleast the following.

iii. General:

- Purchaser's order number and transformer sitedesignation.
- Manufacturer's name and transformer serialnumber.
- Rating oftransformer
- MVA
- Voltages and tappingrange
- Number ofphases
- Frequency
- Rated currents for each winding
- VectorGroup
- CoolingType
- Measured no-load losses and load losses at 75°C.
- Altitude of testbay.
- Designation of terminals supplied and terminalsstrapped.

iv. Top oil temperature risetest:

A log of the following quantities taken at a minimum of 30-minute intervals:

- Time

Notes: The probes may be left in position provided the reliability and integrity of unit will not be jeopardized during its long-life expectancy.

v. Winding temperature risetest

- Record the 'cold' resistance of each winding and the simultaneous top oil and ambient air temperatures, together with the time required for the effect todisappear.
- Record the thermal time constant of thewinding.
- Log the half-hourly readings of the quantities as for the top oil temperature risetest.

- Provide a table of readings, after shut-down of power, giving the following information;
  a) Time after shut-down:
  b) Timeincrement:
  c) Winding resistance: At least 20 minutesreading
  d) Resistanceincrement:
- Provide a record of all calculations, corrections and curves leading to the determination of the winding temperatures at the instant of shut-down of power.
- Record any action taken to remedy instability of the oil surge device during initiation of the oil circulatingpumps.

Temperature measurements as per special probes or sensors (fibre optic) placed at various locations shall also berecorded.

7. DielectricTests

Following Test shall be performed in the sequence given below as per IEC 60076-3:2013 clause 7.2.3 shall be followed:

a) Lightning impulse tests (LIC, LIN)
b) Switching impulse (SI)
c) Applied voltage test (AV)
d) Line terminal AC withstand test (LTAC)
e) Induced voltage test with partial discharge measurement (IVPD)

8. Measurement of transferred surge on LV or Tertiary due to HV & IV Lightning impulse:-

Following tests shall be carried out with applying 20% to 80% of rated Impulse & Switching impulse (upto 60% for IV, Sr. No. 7 & 8 of below table) voltage. Finally, measured value shall be extrapolated for 100% rated voltage.

Table for Transfer surge (Impulse) at Max, Nor. and Min. Voltage Tap

Sr. No.	Impulse Type	Voltage applied	Earthed Points	Open / not earthed point	Measurement Point
1	FW	1.1	2.1, N & 3.2	-	3.1
2	FW	1.1	2.1, N & 3.1	-	3.2
5	FW	2.1	1.1, N & 3.2	-	3.1
6	FW	2.1	1.1, N & 3.1	-	3.2

Similar tests to be conducted for switching surge transformer at Max, Nor. and Min. VoltageTap.

Where 1.1 : HVTerminal
2.1 : IVTerminal
3.1&3.2 : LV or TertiaryTerminal

Acceptance criteria

Transfer surge at Tertiary should not exceed 250kVp at any conditions for 400kV Voltage class Transformer. For other transformer it shall be below the impulse level of LV winding.

8. Chopped wave & full wave lightning impulse test for the line terminals (LIC & LI) and Switchingimpulsetest

Chopped wave lightning impulse and switching impulse test shall be performed at normal and extreme taps on Unit-1, Unit-2 and Unit-3 respectively for 1-Ph unit, otherwise R ph, Y Ph and B Ph respectively for 3-Ph unit. All the parameters as per IEC shall be mentioned in thereport.

9. Measurement of power taken by fans and oil pumps (100 % coolerbank)

Losses of each fan and pumps including spare shall be measured at rated voltage and frequency. Fans and Pumps shall be mounted with cooler bank as per approved drawing during measurement. Serial No, applied voltage, measured current, frequency and make shall be furnished in the test report.

10. TankTests

i. Oil LeakageTest

All tanks and oil filled compartments shall be filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure equal to normal head of oil plus 35 kN/sq.m (5 psi) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12hours for oil and 1 hour for air during which no leakage shall occur.

ii. VacuumTest

All transformer tanks shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq. absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specifiedbelow:

Horizontal Length (inmm)	Permanent deflection of flat plate(inmm)
Up to andincluding750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

iii. PressureTest

All transformer tanks, its radiator, conservator and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or normal oil head pressure plus 35 KN/sq.m whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

11. Dynamic short circuit withstand test shall be carried out as per IEC 60076-5. Dynamic short circuit test shall be carried out in HV-IV combination at nominal & extreme tap positions. For LV winding, dynamic short circuit shall be carried out either on HV-LV or IV-LV combination, whichever draws higher short circuit current as per calculation. Type tests shall be carried out before short circuit test. Following shall also be conducted before and after Short Circuit test:

i) Dissolved gas analysis
ii) Frequency response analysis
iii) All routine tests

Detail test procedure shall be submitted by contractor & shall be approved before short circuit test.

12. Routine test on bushings shall be done as per IEC60137.

Annexure - I

Test Plan

No.	Test	132≥ Um≤170kV	U_m> 170kV
1.	Measurement of winding resistance	Routine	Routine
2.	Voltage ratio measurement	Routine	Routine
3.	Polarity test	Routine	Routine
4.	No-load loss and current measurement	Routine	Routine
5.	Magnetic balance test (for three phase Transformer only)	Routine	Routine
6.	Impedance and load loss measurement	Routine	Routine
7.	Measurement of insulation resistance & Polarization Index	Routine	Routine
8.	Measurement of insulation power factor and capacitance between winding and earth and Bushings	Routine	Routine
9.	Full wave lightning impulse test for the line terminals (LI)	Routine	-
10.	Induced voltage withstand test (IVW)	Routine	-
11.	Applied voltage test (AV)	Routine	Routine
12.	Induced voltage test with PD measurement (IVPD)	Routine	Routine
13.	On-load tap changer test (Ten complete cycle before LV test)	Routine	Routine
14.	Gas-in-oil analysis	Routine	Routine
15.	Core assembly dielectric and earthing continuity test	Routine	Routine
16.	Oil leakage test on transformer tank	Routine	Routine
17.	Appearance, construction and dimension check	Routine	Routine
18.	Short duration heat run test (Not Applicable for unit on which temperature rise test is performed)	Routine	Routine
19.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.	Routine	Routine
20	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine	Routine
21.	High voltage with stand test on auxiliary equipment and wiring after assembly	Routine	Routine
22.	Tank vacuum test	Routine	Routine
23.	Tank pressure test	Routine	Routine
24.	Chopped wave lightning impulse test for the line terminals (LIC)	Type	Routine
25.	Switching impulse test for the line terminal (SI)	Type	Routine
26	Line terminal AC withstand voltage test (LTAC)	Routine	Type
27.	Measurement of transferred surge on LV or Tertiary as applicable due to HV lightning impulse and IV lighting impulse (as applicable)	Type	Type
28.	Lightning impulse test for the neutral terminals (LIN)	Type	Type
29.	Temperature rise test	Type	Type
30.	Measurement of Zero seq. reactance (for three phase Transformer only)	Type	Type
31.	Measurement of harmonic level in no load current	Type	Type
32.	Measurement of acoustic noise level	Type	Type
33.	Measurement of power taken by fans and oil pumps (Not applicable for ONAN)	Type	Type

34.	Dynamic Short circuit withstand test	Type	Type

ANNEXURE J

PT 100 Resistance (TemperatureVsResistance)

(BS 1904: 1984 & IEC 751: 1985)

TEMP °C	RESISTANCE (OHMS)		
	LOW	NOMINAL	HIGH
0	99.88	100.00	100.12
10	103.76	103.90	104.04
20	107.63	107.79	107.95
30	111.49	111.67	111.85
40	115.35	115.54	115.73
50	119.19	119.40	119.61
60	123.01	123.24	123.47
70	126.82	127.07	127.32
80	130.62	130.89	131.16
90	134.42	134.70	134.98
100	138.20	138.50	138.80
110	141.97	142.29	142.61
120	145.72	146.06	146.40
130	149.46	149.82	150.18
140	153.21	153.58	153.95
150	156.92	157.31	157.70

PT 100 (TemperatureVs Output Signal)

TemperatureRange:0-150^{O}c

Signal Range: 4-20 mA

TEMPERATURE °C	NOMINAL RESISTANCE (OHMS)	OUTPUT SIGNAL RANGE (4 - 20mA)		
		LOW	NOMINAL	HIGH
0	100.00	3.800	4.000	4.200
10	103.90	4.867	5.067	5.267
20	107.79	5.933	6.133	6.333
30	111.67	7.000	7.200	7.400
40	115.54	8.066	8.266	8.466
50	119.40	9.133	9.333	9.533
60	123.24	10.200	10.400	10.600
70	127.07	11.266	11.466	11.666
80	130.89	12.333	12.533	12.733
90	134.70	13.399	13.599	13.799
100	138.50	14.466	14.666	14.866
110	142.29	15.533	15.733	15.933
120	146.06	16.599	16.799	16.999
130	149.82	17.666	17.866	18.066
140	153.58	18.732	18.932	19.132
150	157.31	19.800	20.000	20.200

ANNEXURE - K

Online Dissolved Gas (Multi-gas) and Moisture Analyser

1.1. Online Dissolved Gas (Multi-gas) and Moisture Analyser along with all required accessories including inbuilt display shall be provided with each Transformer for measurement & analysis of dissolved gases and moisture in the oil. Interpretations shall be as per IEC60599-1999.

1.2. The equipment shall detect, measure and analyse the followinggases:

Gases & Moisture Parameters	Typical Detection Range
H_2	5 – 5,000 ppm
CH_4	5 – 5,000 ppm
C_2H_6	5 – 5,000 ppm
C_2H_4	3 – 5,000 ppm
C_2H_2	1 – 3,000 ppm
CO	10 – 10,000 ppm
CO_2	20 – 30,000 ppm
H_2O	2 – 100 % RS should have facility for measurement of moisture in oil in ppm

1.3. The analyser should measure (not calculate) all above gases and should have 100% sensitivity. The equipment shall be capable of transferring data to sub-station automation system confirming to IEC 61850. Necessary interface arrangement shall be provided by the contractor for integration with automation system. The necessary type test report for such confirmation shall be submitted duringdetailed engineering.

1.4. Equipment shall have facility to give SMS alert to at least three users whenever any fault gas violates the predefinedlimit.

1.5. Equipment should work on station auxiliary supply. In case other supply is required for the equipment then suitable converter shall be included. All the necessary power and control cables, communication cables, cable accessories as required shall be provided by the supplier.

1.6. Online DGA shall be installed out door on Transformer in harsh ambient and noisy condition (Electromagnetic induction, Corona, and capacitive coupling). Equipment shall be mounted separately on ground. Suitable arrangement shall be provided to support and protect the inlet and outlet piping arrangement. The connecting oil lines must be of Stainless-Steel rigid pipes or flexible hoses. The equipment shall be suitable for proper operation in EHV substation (800kV) environment where switching takes place in the EHV/HV System. The suitable indications for power On, Alarm, Caution, normal operation etc. shall be provided on the front panel of the equipment. The equipment shall have IP55 Stainless Steel enclosure, suitable for 55 ^{0}C ambient temperature and EMI and EMC compatibility. The Equipment must carry a minimum of five (5) years manufacturer'sWarranty.

1.7. The equipment shall display all the individual gas and moisture concentration on its display unit and shall have facility to download all the stored the data from the unit for further analysis. The sampling rate shall be selectable as 2 or 4 or 6 or 12 hours etc. The equipment shall have inbuilt memory to store these results for complete one year even if sampling is done at the lowest interval. The carrier and calibration gas (if applicable) shall have minimum capacity to work for atleast three years without replacement. All the consumable (if any) upto warrantee period shall be included in the scope of supply.

1.8. The Equipment must have an automatic Calibration facility at fixed intervals. For calibration if anything required including cylinder must be mounted with the Equipment.

1.9. The technical feature of the equipment shall be asunder:

Accuracy	+ 10%
Repeatability	+3% to 10% depending upon gases
Oil temperature range	- 20^0 C to + 120^0 C
External Temp. Range	- 20^0 C to + 55^0 C (External temp range of 55^0 C is important and should not be compromise due to Indian ambient & operating conditions.)
Humidity range	10 to 95 %
Operating Voltage	230 Vac; 50 Hz (±20% variation)
Communications	USB&IEC 61850 compliant

1.10. Software for fault indication and fault diagnostics shall include following:

Fault indication:

i) IEEE, IEC, or user configurable levels of dissolvedgases
ii) Rate of change trending

Fault Diagnosis:

i) Keygases
ii) Ratios (Rogers, IEC.etc.)
iii) Duval'sTriangle

1.11. The equipment shall be supplied with all necessary accessories required for carrying out DGA of oil sample complete in all respect as per the technical specification. The following shall be also forming a part of supply.

i) Software
ii) Operation Manual (2 set for every unit),
iii) Software Manual and
iv) Compact disc giving operation procedures of Maintenance Manual & Trouble shooting instructions.

1.12. The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certified representative.

1.13. The equipment shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over the test setup. During this period, if the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of, spares, software, transportation etc. of kit for repair at test lab/works. Further, supplier shall make alternate arrangement for smooth operation of the transformer.

Annexure - L

LIST OF TESTING EQUIPMENT

Sr. No.	Testing Equipment	Make & Model *
1	Automatic Transformer Oil BDV Testing Kit	DTA-100C (BAUR), OTS100AF-UKU-PX (Megger)
2	Oil Storage Tank (With Wheels)- 20kL Capacity	VPI / CEE DEE VACUUM / SICORP
3	Stainless Steel Oil sampling bottle (One Litre Capacity)	SCIENO TECH 1 litre
4	Syringes for sampling oil	Tomopol (Industrial Grade)

**** Bidder may offer equivalent or superior testing equipment.***

ANNEXURE - M

1.1 KV GRADE POWER & CONTROL CABLES

1.1 All Power & Control cables shall be supplied from reputed vendors.

1.2 Separate cables shall be used for AC & DC.

1.2 Separate cables shall be used for DC1 & DC2.

1.3 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.

1.4 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All aluminium used in the cables shall be of H2 grade.

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

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

1.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS: 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

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

1.9 All the cables shall conform to fire resistance test as per IS: 1554 (Part - I).

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

1.11 Repaired cables shall not be accepted.

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

1.13 **PVC Power Cables**

1.13.1 The PVC (70°C) insulated 1100V grade power cables s hall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read along with this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multi core cables. For multi core 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. The contractor can used copper cable of required size.

1.14 **PVC Control Cables**

1.14.1 The 1100V grade 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 except where specifically advised by the Employer to be black.

1.14.2 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).

STANDARD TECHNICAL DATA SHEET (1.1kVGRADEXLPE POWERCABLES)

SL. No	Description	Parameters	
1a	Cable Sizes	1 C x 630	3½ C x300
b	Manufacturer's type designation	A2XWaY	A2XWY

2	Applicable standard	IS:7098/PT-I/1988 & its referred specifications	
3	Rated Voltage(volts)	1100V Grade	
4	Type & Category	FR&C1	FR&C1
5	Suitable for earthed or unearthed system	For both	
6	Continuous current rating when laid in air in an ambient temp. of 50°C and for maximum conductor temp. of 70°C of PVC Cables [For information only]	732	410
7	Rating factors applicable to the current ratings for various conditions of installation	AsperIS-3961-Pt-II-67	
8	Short circuit Capacity		
a	Guaranteed Short Circuit Amp. (rms) KA for 0.12 sec duration at rated conductor temperature of 90 degree C, with an initial peak of 105 KA	45kA	45kA
b	Maximum Conductor temp. allowed for the short circuit duty(degC.) as stated above	250°C	
9	Conductor		
a	Material	StrandedAluminiumas perClass2 of IS : 8130	
b	Grade	H2(Electrolyticg rade)	
c	Cross Section area (Sq.mm.)	630	300/150
d	Number of wires (No.) minimum	53	30/15
e	FormofConductor	Stranded and compacted circular	Strandedcompactedcircular/sector shaped
f	Directionoflayofstrandedlayers	Outermost layer shall be R.H lay & opposite In successive layers	
10	Conductor resistance (DC)at20°C per km-maximum	0.0469	0.1/0.206
11	Insulation		
a	Compositionofinsulation	ExtrudedXLPEas perIS-7098 Part (1)	
b	Nominalthicknessofinsulation(mm)	2.8	1.8/1.4
c	Minimumthicknessofinsulation	2.42	1.52/1.16
12	InnerSheath		
a	Material	ExtrudedPVCtypeST-2asper IS-5831-84	
b	Calculated diameter over the laid-up cores, (mm)	NA	52
c	Thickness of Sheath(minimum) mm	NA	0.6
d	Method of extrusion	NA	Pressure/Vacuum extrusion
13	Armour		
a	Type and material of armour	Alwire[H4grade]	Gal.Steelwire
b	Direction of armouring	Lefthand	
c	Calculated diameter of cable over inner sheath (under armour), mm	33.9	53.2
d	Nominal diameter of round armour wire(minimum)	2	2.5

e	GuaranteedShortcircuitcapacityofthearmourfor 0.12secatroomtemperature.	45kA	45kA
f	DCresistanceat 20 °C(Ω/Km)	$	0.577
14	Outer Sheath	ST-2 & FR	ST-2 & FR
A	Material (PVC Type)	38.3	59.50
B	Calculated diameter under the sheath	1.72	2.36
C	Min. thickness of sheath(mm)	Min 29.0	Min 29.0
D	Guaranteed value of minimum oxygen index of outer sheath at 27 oC	Min 250	Min 250
E	Guaranteed value of minimum temperature index at 21 oxygen indices	Black	Black
f	colour of sheath	$	$
15a	NominalOveralldiameterofcable	+2/-2mm	
b	Toleranceonoveralldiameter(mm)	shall conformtoIS 10418andtechnical specification	
16	CableDrums	1000/500	1000/500
a	Max./Standardlengthperdrumforeachsizeofcable(singlel ength) with±5%Tolerance(mtrs)		
b	Non-standarddrumlengths	Maximum one (1) non-standard lengths ofeach cable size may be supplied in drumsonlyover&abovethestandardlengths as Specified above. (ifrequiredforcompletionofproject)	
17	Whetherprogressivesequentialmarkingonoutersheathprovid ed at1 meterinterval18	Yes	
18	Identificationofcores		
a	colourofcores	AsperIS7098 Part (1)	
b	Numbering	NA	
19	WhetherCablesofferedareISImarked	Yes	
20	WhetherCablesofferedaresuitableforlayingas per IS 1255	Yes	

As per manufacturer design data

STANDARD TECHNICAL DATA SHEET-1.1kV GRADE PVC POWER CABLES

SN	Description	Parameters					
1a	Cable Sizes	1 cx 150	3.5 c x 70	3.5 c x 35	4 c x16	4c x 6	2 c x6
1b	Manufacturer's type designation	AYWaY	AYFY	AYFY	AYFY	AYWY	AYWY
2	Applicable standard	IS:1554/PT-I/1988&itsreferredstandards					
3	Rated Voltage(volts)	1100Vgrade					
4	Type & Category	FR& C1	FR& C1	FR& C1	FR& C1	FR& C1	FR& C1
5	Suitable for earthed or unearthed system	forboth					
6	Continuous current rating whenlaid in air in a ambient temp. of50oC and for maximum conductor temp. of 70 deg CofPVCCables [Forinformationonly]	202	105	70	41	24	28
7	Rating factors applicable to the current ratings for various Conditions of installation:	AsperIS-3961-Pt-II-67					
8	Short circuit Capacity						
a)	Short Circuit Amp. (rms)KA for 1 Sec duration	11.2	5.22	2.61	1.19	0.448	0.448
b)	Conductortemp.allowedforthe short circuit duty(degC.)	160^0C					
9	Conductor						
a)	Material	STRANDEDALUMINIUM					
b)	Grade	H2(Electrolyticgrade)					
c)	Cross Section area (Sq.mm.)	150	M-70 N-35	M-35 N-16	16	6	6
d)	Number of wires (No.)	asperTable2of IS 8130					
e)	Form of Conductor	Non-compact edStran ded circular	shapedc onducto r	shape dcondu ctor	shape dcondu ctor	Non-compact edStran ded circular	Non-compact edStran ded circular
f)	Direction of lay of stranded layers	Outermost layer shall be R.H lay & opposite in successive layer					
10	Conductor resistance (DC) at 20oCperkm-maximum	0.206	0.443/0 .868	0.868/ 1.91	1.91	4.61	4.61
11	Insulation						
a)	Compositionofinsulation	ExtrudedPVCtypeAas per IS-5831-84					
b)	Nominalthicknessof insulation(mm)	2.1	1.4/1.2	1.2/1.0	1.0	1.0	1.0
c)	Minimumthicknessofinsulation	1.79	1.16/0.9 8	0.98/0. 8	0.8	0.8	0.8
12	InnerSheath						
a)	Material	Extruded PVC type ST-Iasper IS-5831-84					

b)	Calculated diameter over the laid Up cores, (mm)	N. A	27.6	20.4	15.7	11.6	9.6
c)	Thickness of Sheath(minimum) mm	N. A	0.4	0.3	0.3	0.3	0.3
13	Armour	asper IS3975/88					
a)	a) Type and material of armour	Al. Wire[H 4grade]	Gal.ste elstrip	Gal.st eelst rip	Gal.ste elstri p	Gal.ste elwir e	Gal.ste elwir e
b)	b) Direction of armouring	lefthand					
c)	c) Calculated diameterof cable over inner sheath (under armour), mm	18	28.4	21	16.3	12.2	10.2
d)	d)Nominal diameter of round armour wire/strip	1.6 4	0.8 4	0.8 4	0.8	1.4	1.4
e)	e) Number of armour wires/strips	Armouring shall be as close as practicable					
f)	f) short circuit capacity of thearmour along for 1 sec-for infoonly	Kx A√t(KAmp) (where A=total area of armour in mm^2&t=time in seconds),K=0.091for Al & 0.05 for steel					
g)	g) DC resistance at 20°C(Ω/Km)	0.44	2.57	3.38 4	3.99	3.76	4.4
14	Outer Sheath						
a)	a) Material (PVCType)	ST-1&FR	ST-1&FR	ST-1& FR	ST-1&FR	ST-1&FR	ST-1&FR
b)	b) Calculated diameter under the sheath	21.2	30.1	22.6	17.9	15	13
c)	c)Min.thickness of sheath(mm)	1.4	1.56	1.4	1.4	1.4	1.24
d)	d)Guaranteed value of minimum oxygen index of outer sheath at27oC	Min2 9.0	Min2 9.0	Min 29.0	Min2 9.0	Min2 9.0	Min2 9.0
e)	e) Guaranteed value of minimum temperature index at 21 oxygen indices	Min2 50	Min2 50	Min 250	Min2 50	Min2 50	Min250
f)	f) Colour of sheath	Black	Black	Black	Black	Black	Black
15a)	a) Overall diameter of cable	$					
b)	b) Tolerance on over all diameter (mm)	+2/-2mm					
16	CableDrums	shallconformtoIS10418andtechnicalspecification					
a)	a) Max./ Standard length per drum for each size of cable (single length) with ±5%Tolerance(mtrs)	1000/50 0	1000/50 0	1000/5 00	1000/50 0	1000/50 0	1000/50 0
b)	b) Non standard drum lengths	Maximum one (1) non standard lengths of each cable size may be supplied in drums only over & above the standard lengths as specified above. (if required for completion of project)					
17	Whether progressive sequential Marking on outer sheath provided	Yes					
18	Identification of cores						
a)	a) colour of cores	Red	R, Y, Bl	R, Y, B	R, Y, Bl	R, Y, Bl	Red &

			&Bk	l&Bk	&Bk	&Bk	Bk
b)	b) Numbering	N.A	N.A	N.A	N.A	N.A	N.A
19	Whether Cables offered are ISI Marked	YES					
20	Whether Cables offered are Suitable for laying as per IS 1255	YES					

-As per manufacturer design data

STANDARD TECHNICAL DATASHEET-1.1kV GRADE PVC CONTROL CABLES

Sl. No	Description	Parameters							
1a	CableSizes	2 cx 2.5	3ccx2 .5	5c x2.5	7 cx 2.5	10 cx 2.5	14 cx 2.5	19 c x2.5	27 cx 2.5
1b	Manufacturer's type designation	YWY	YWY	YWY	YWY	YWY	YWY	YWY	YWY
2	Applicable standard	IS:1554/PT-I/1988 & its referred standards							
3	Rated Voltage(volts)	1100Vgrade							
4	Type & Category	FR&C1							
5	Suitable for earthed or unearthed system	forboth							
6	Continuous current rating when laid in air in an ambient temp. of 50oC and for maximum conductor temp. of 70oC of PVC Cables [For information only]	22	19	19	14	12	10.5	9.7	8
7	Rating factors applicable to the current ratings for various conditions of installation:	AsperIS-3961-Pt-II-67							
8	Short circuit Capacity								
a)	Short Circuit Amp. (rms)KA for 1 sec duration	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285
b)	Conductor temp. allowed for the short circuit duty(degC.)	160^{0}C							
9	Conductor								
a)	Material	Plain annealed High Conductivity stranded Copper (as per IS8130/84)							
b)	Grade	Electrolytic							

c)	Cross Section area (Sq.mm.)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
d)	Number of wires (No.)	As perTable2 of IS 8130							
e)	Form of Conductor	Non-compacted Stranded circular shaped conductor							
f)	Direction of lay of Stranded layers	Outermost layer shall be R.H lay							
10	Conductor resistance (DC) at 20oC per km-maximum	7.41	7.41	7.41	7.41	7.41	7.41	7.41	7.41
11	Insulation								
a)	Composition of Insulation	Extruded PVC type A as per IS-5831-84							
b)	Nominal thickness of insulation(mm)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
c)	Minimum thickness of Insulation	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
12	Inner Sheath								
a)	Material	ExtrudedPVCtypeST-Iasper IS-5831-84							
b)	Calculated diameter over the laidup cores, (mm)	7.2	7.8	9.7	10.8	14.4	15.9	18	22.1
c)	Thickness of Sheath (minimum) mm	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
13	Armour	asper IS 3975/99							
a)	Type and material of Armour	Gal.Steel Wire							
b)	Direction of armouring	Left hand							
c)	Calculated diameter of cable over inner sheath (underarmour), mm	7.8	8.4	10.3	11.4	15	6.5	18.6	22.7
d)	Nominal diameter of round armour wire/strip	1.4	1.4	1.4	1.4	1.6	1.6	1.6	1.6
e)	Number of armours wires/strips	Armouring shall be as close as practicable							
f)	Shortcircuit capacity of The armour along for 1 sec-for info only	0.05xA√t(Kamp) (whereA=total area of armour in mm2 & t =time in seconds)							
g)	DC resistance at 20oC(Ω/Km) & Resistivity	AsperIS 1554 Part (1), wherever applicable and IS3975-1999							
14	Outer Sheath								
a)	Material (PVCType)	ST-1&FR							
b)	Calculated diameter Under the sheath	10.6	11.2	13.1	14.2	18.2	19.7	21.8	25.9
c)	Min.thickness of sheath(mm)	1.24	1.24	1.24	1.24	1.4	1.4	1.4	1.56

d)	Guaranteed value of minimum oxygen index Of outer sheath at 27oC	Min2 9.0	Min2 9.0	Min2 9.0	Min2 9.0	Min2 9.0	Min2 9.0	Min2 9.0	Min2 9.0
e)	Guaranteed value of minimum temperature index at 21 oxygen index	Min2 50	Min2 50	Min2 50	Min2 50	Min2 50	Min2 50	Min2 50	Min2 50
f)	Colour of sheath	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey
15a)	Overall diameter of cable	$							
b)	Tolerance on overall diameter(mm)	+2/-2mm							
16	Cable Drums	Shall conform to IS10418 and technical specification							
a)	Max./ Standard length per drum for each size of cable (single length) With ±5% Tolerance(mtrs)	1000/500							
b)	Non standard drum lengths	**Maximum one (1) non standard lengths of each cable size may be supplied in drums only over & above the standard lengths as specified above. (if required for completion of project)**							
17	Whether progressive sequential marking on Outer sheath provided								
18	Identification of cores	Yes							
a)	Colour of cores	R &Bk	R,Y &Bl	RedR, Y,Bl	Grey	Grey	Grey	Grey	Grey
b)	Numbering	N.A	N.A	N.A	Numerals in black ink				
19	Whether Cables offered are ISI marked	YES							
20	Whether Cables offered Are suitable for laying as per IS 1255	YES							

As per manufacturer design data

ANNEXURE-N

Technical Specification of Oil BDV Test Set (If specified in BPS)

Item	**Specification**
Functional Requirement	1. The instrument should be suitable for Automatic Measurement of Electrical Breakdown Strength of Transformer oil as per relevant standards. 2. The test results should have repeatability, consistency in laboratory condition.
Test Output	0-100 kV (Rate of rise: 0.5 to 5KV/Sec)
Accuracy	± 1 kV
Resolution	0.1 KV
Switch off Time	≤ 1ms
Display/Control	LCD/Keypads.
Printer	Inbuilt/External
Measurement Programmes	Fully Automatic Pre-programmed/User programmed Test Sequences including as per latest IEC & other national/international standards.
Test Lead/ Accessories	One complete set of electrodes, gauge etc. compatible with the instruments should be provided for successfully carrying out the test in EMPLYER S/S.Additionally, all the required accessories, tools, drawing, documents should be provided forthe smooth functioning of kit. Further hard carrying case (which should berobust/rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.
Design/Engg.	The complete equipment along with complete accessories must be designed / engineered by Original Equipment Manufacturer.
Power Supply	It shall work on input supply variations, V: 230 ±10 %, f: 50 Hz ±5 % on standard sockets.
Operating Temperature	0 to +50 deg C
Relative humidity	Max. 90% non-condensing.
Protection/ Control	Against short circuit, over load, transient surges etc. Also, the instrument should have facility of stopping automatically on power failure. Also, the kit should have facility of HV chamber interlocking as well as zero start interlocking.
Environment	The test kit shall be compatible for EMI/EMC/Safety environment requirement as per IEC.
Guarantee	Warranty/Guarantee Period: Min 05 year from the date of successful & complete commissioning at Employer sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier’s works forrepairswithinwarranty/guaranty period, suppliers will have to bear the cost of spares, software, transportation of kit for repair at test lab / works.
Calibration Certificate	Unit shall be duly calibrated before supply and the date of calibration shall not be older than two months from the date of supply of Kit.
Training	Supplier shall have to ensure that the instrument is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to EMPLYER engineers.
Commissioning, handing overthe Instrument	Successful bidder will have to commission the instrument to the satisfaction of EMPLOYER. The instrument failed during the demonstration shall be rejected and no repairs are allowed.
After sales service	Bidder will have to submit the documentary evidence of having established mechanism in India for prompt services.

ANNEXURE - O

Technical Specification of Portable Dissolved Gas Analysis of Oil (If specified in BPS)

Sl.No.	Particulars	Specification
01	Functional Requirement	The Portable DGA equipment to extract, detect, analyze and display the dissolved gases in insulating oil as specified in IEEE C 57-104- 2008 and IEC 60599-2007.
02	Detection of Gases	All the fault gases i.e., H2, CH4, C2H2, C2H4, C2H6, CO & CO2 concentrations shall be individually measured and displayed. The minimum detection limits of the instrument for the above gases shall strictly be met the requirement of IEC-60567-2011-Page No. 47- clause 9.2, table-5.
03	Power Supply	It shall be operated with AC single phase,50 Hz +/-5%, 230 V +/- 10% supply. All power cable and necessary adaptors shall be provided by supplier.
0	Instrument control and Data handling, Internal Memory	a) Instrument shall be having in-built control for all the functions (data acquisitions and data storage), it shall have a facility for communication with computer for downloading the data from instrument via USBport. b) Laptop shall be provided for communication with the instrument. it shall be of latest specification along with licensed pre loaded OS and software as well as software for interpreting DGA results accordance with IEEE C 57-104-1991 and IEC 60559-1999. Laptop carrying case shall also beprovided. c) Internal Memory can capable of store atleast 15000 records
5	General Conditions	a) Performance Parameters like - Minimum Detection Limits, Working Range, Accuracy, repeatability etc. shall be finalized during detailed engineering. b) The portable DGA equipment supplier shall demonstrate during commissioning of the kit that the results shown by the kit are within the specified accuracy and repeatability range and EMPLOYER will provide only the insulating oil/ GAS-IN-OIL standard for testing. c) All required items/instruments /spares /consumable /connecting cables/communication cables/instruments/manuals/Certificates/training materials/original software/original licensed data/station operating software/education CD/DVDs that are essential to understand and operate the instrument shall be supplied at no extra cost.
06	Operating Temperature, Relative humidity & Dimensions	01. Temperature 0-50 Deg. C 02. 85%non-condensing 03. Portable
07	Warranty	The entire test set up shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over the test set up. During this period, if the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of, spares, software, transportation etc. of kit for repair at testlab/works.
08	Service Support	The supplier shall furnish the requisite documents ensuring that the equipment manufacturer is having adequate service team andfacility in India to take care of any issues during operation of theinstrument.

09	Training	The supplier shall provide adequate training for a period of two working days pertaining to the operation and troubleshooting to site personnel.

ANNEXURE - P

On Line Dissolved Hydrogen and Moisture Monitor

1.0 Online Dissolved Hydrogen and Moisture Analyser along with all required accessories including in built display shall be provided with each Transformer for measurement & analysis of dissolved gases and moisture in the oil. Interpretations shall be as per IEC 60599-1999

2.0 The equipment shall be capable of transferring data to sub-station automation system confirming to IEC 61850. Necessary interface arrangement shallbeprovidedbythecontractor for integration with automation system. The necessary type test report for such confirmation shall be submitted during detailedengineering

3.0 Equipment should work on station auxiliary supply. In case other supply is required for the equipment then suitable converter shall be included. All the necessary power and control cables, communication cables, cable accessories as required shall be provided by the supplier

4.0 Equipment shall be installed out door on Transformer in harsh ambient and noisy condition (Electromagnetic induction, Corona, and capacitive coupling). Equipment shall be mounted separately on ground. Suitable arrangement shall be provided to support and protect the inlet and outlet piping arrangement. The connecting oil lines must be of Stainless-Steel rigid pipes or flexible hoses. The equipment shall be suitable for proper operation in EHV substation (800kV) environment where switching takes place in the EHV/HV System. The suitable indications for power On, Alarm, Caution, normal operation etc. shall be provided on the front panel of the equipment. The equipment shall have IP55 Stainless Steel enclosure, suitable for 55 ^{0}C ambient temperature and EMI and EMC compatibility. The Equipment must carry a minimum of five (5) years manufacturer's Warranty

5.0 The equipment shall display H2 and moisture concentration on its display unit and shall have facility to download all the stored the data from the unit for further analysis. The sampling rate shall be selectable as 2 or 4 or 6 or 12 hours etc. The equipment shall have in built memory to store these results for complete one year even if sampling is done at the lowest interval. All the consumable (if any) upto warrantee period shall be included in the scope of supply

6.0 The monitor shall also be suitable to detect Water Content measured in ppm or % RS (Relative Saturation). The sensors shall be able to withstand pressure from vacuum to 10 psi.

7.0 TechnicalParameters:

Sr. No.	Parameters	Requirements
a)	The measurement range / Output:	
	Hydrogen Dissolved in oil	0 to 2000 ppm, with 4 – 20 mA output
	Water Dissolved in oil	0 to 95% RS, with 4 – 20 mA output
b)	Alarms/Indication (High & Very High)	
	Hydrogen	Programmable NO/NC contacts,
	Water	Programmable NO/NC contacts,
c)	Environment	
	Operating Ambient Temperature	– 20 to + 55 degC
	Operating Oil Temperature	– 20 to + 105 degC

d)	Pressure Withstand, (Oil side)	Full Vacuum to 10 psi.
e)	Communications	USB&IEC 61850 compliant

Equipment shall be mounted separately to avoid effect of vibration. Suitable arrangement shall be provided support and protect the inlet and outlet piping arrangement.

8.0 Software for fault indication and fault diagnostics shall include following:

i) Fault indication

ii) IEEE, IEC or user configurable levels of dissolved gases

iii) Rate of change trending

9.0 The equipment shall be supplied with all necessary accessories required for carrying out DGA of oil sample complete in all respect as per the technical specification. The following shall be also forming a part of supply:

Software

i) Operation Manual (2 set for every unit),

ii) Software Manual and

iii) Compact disc giving operation procedures of Maintenance Manual & Trouble shooting instructions.

10.0 The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certified representative.

11.0 The equipment shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over the test set up. During this period, if the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of, spares, software, transportation etc. of kit for repair at test lab/works. Further supplier shall make alternate arrangement for smooth operation of the transformer.

ANNEXURE – Q

On-line insulating oil drying system (Cartridge type)

In addition to provision of air cell in conservators for sealing of the oil system against the atmosphere, each Transformer shall be provovided with an on-line insulating oil drying system of adequate rating with proven field performance. This system shall be separately ground mounted and shall be housed in metallic (stainless steel) enclosure. The bidder shall submit the mounting arrangement. This on-line insulating oil drying system shall be:

i. Designed for very slow removal of moisture that may enter the oil system or generated during cellulose decomposition. Oil flow to the equipment shall be controlled through pump of suitable capacity (at least 5LPM).

ii. The equipment shall display the moisture content in oil (PPM) of the inlet and outlet oil from the dryingsystem.

iii. In case, drying system is transported without oil, the same shall be suitable for withstanding vacuum to ensure that no air / contamination is trapped duringcommissioning.

iv. In case, drying system is transported with oil, the oil shall conform to EMPLOYER specification for unused oil. Before installation at site, oil sample shall be tested to avoid contamination of main tank oil.

v. Minimum capacity of moisture extraction shall be 10 Litres before replacement of cartridge. Calculation to prove the adequacy of sizing of the on-line insulating oil-drying system along with make and model shall be submitted for approval of purchaser during detail engineering.

vi. The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certifiedrepresentative.

vii. The equipment shall be capable of transferring data to substation automation system confirming to IEC 61850 through FO port. Necessary interface arrangement shall be provided by the contractor for integration with automation system.

   The entire test set up shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over the test setup. During this period, if the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of,
   spares, software, transportation etc. of kit for repair at testlab/works.

viii. The equipment shall be supplied with Operation Manual (2 set for every unit), Software (if any), and Compact disc giving operation procedures of Maintenance Manual & Trouble shootinginstructions.

ANNEXURE - R

Nitrogen Injection Type Fire Prevention & Extinguishing System

1. Nitrogen Injection Type Fire Protection System (NIFPS)shall be designed to prevent explosion of transformer tank and the fire during internal faults/arc.

   The system shall work on the principle of Drain & stir. On activation, it shall drain a pre- determined quantity of oil from the tank top through drain valve to reduce the tank pressure, isolate conservator tank oil and inject nitrogen gas at high pressure from the bottom side of the tank through inlet valves to create stirring action and reduce the temperature of oil below flash point to extinguish the fire. On operation, the quantity of oil removed from the tank shall be such that adequate amount of oil shall remain to cover active part (i.e., core coil assembly).

   Electrical isolation of transformer shall be an essential pre-condition for activating the system.

2. Operational Controls
   The system operation shall be fully automatic and activate from the required fire and othertrip signals. In addition to automatic operation, remote operation from control room/ remotecentre and local manual control in the fire extinguishing cubicle shall also be provided. System shall operate on following situations:

2.1 Prevention of transformer from explosion andfire
To prevent transformer from explosion and fire in case of an internal fault, signals given by operation of Electrical protection relays (Differential / Restricted earth fault) and tripping of circuit breaker of transformer and operation of either Buchholz relay or pressure relief valve (PRV) shall be used to activate the system. The exact logic for system activation shall be finalized during detailed engineering.

2.2 Prevention of transformer from fire in case of fire, sensed by fire detectors, the system shall be activated only after electrical isolation of the transformer, confirmed by breaker trip. If the fire detection is not associated with any other fault, the system activation shall be only manual. Manual operation switch shall be provided in the control room with a cover to avoid accidental operation of it.

3. Operation ofSystem
   On receiving activation signal, the following shall take place:
   i) Open the quick opening drain valve to drain the top layeroil
   ii) Shut off the conservator isolation valve to prevent flow of oil from the Conservator tank to the main tank
   iii) Open the valve to inject Nitrogen into the transformer tank to create stirring of oil.
   There shall be interlock to prevent activation of the system if the transformer is not electrically isolated.
   There shall also be provision for isolating the system during maintenance and/or testing of the transformer.

4. Technical Particulars

   The contractor shall be responsible for the design of the complete system and shall submit the drawings and design calculations for the number of fire detectors, pipe sizing of drain pipe and Nitrogen injection pipe, Nitrogen cylinder capacity, number of injection points, etc. and get approval from AEGCL.

Facility shall be provided to test the system when the transformer is in service, without draining the oil and injecting Nitrogen.

The Nitrogen regulator valve shall be designed in such a way that the Nitrogen shall not enter the transformer tank even in case of passing/ leakage of valve.

Owner shall provide two distinct station auxiliary DC feeders for control purposes. The system shall work on station DC supply with voltage variation defined in GTR.The control box of fire protection system shall have facility to receive these feeders for auto changeover of supply. It shall be the contractor's responsibility to further distribute power to the required locations. In case auxiliary DC power supply requirement is different than station auxiliary DC supply, then all necessary DC-DC converters shall be provided by the Contractor.

Following minimum indications and alarms shall be provided in the local cubicle as well as in the control box: -

- Nitrogen cylinder pressure indication-manometer with sufficient number of adjustable NO contacts
- Nitrogen cylinder pressure low
- Fire inTransformer
- Oil drainstarted
- Conservator oil isolation valveclosed
- Nitrogen injection started
- DC supply fail
- Oil drain valve closed
- Gas inlet valve closed

5. Details of Supply of System Equipment and Other Related Activities:

The scope of supply shall include the following items and any other items required for safe and trouble-free operation of the system.

i) Fire extinguishing cubicle with base frame and containing at least thefollowing:
    - Nitrogen gas cylinder of sufficient capacity with pressure regulator and manometer with sufficient number of adjustable NOcontacts.
    - Oil Drain Assembly including oil drainpipe extension of suitable size for connecting pipes to oilpit
    - Mechanical release device for oil drain and nitrogenrelease
    - Limit switches for monitoring of thesystems
    - Panellighting
    - Flangesontopofthepanelforconnectingoildrainandnitrogeninjectionpipes fortransformer
    - Back up pressure switch to operate nitrogen gasvalve
    - Pressure indicators for Nitrogen pressure of the cylinder and actual injection through Nitrogen regulator
    - Fire Extinguishing Cubicle shall have oil leakage detection arrangement for detecting

oil leakage from drain valve. In case of any oil leakages, alarm to be provided.

- shall have minimum IP55 degree ofprotection

ii) Control box to be installed in the control room of the station for monitoring system operation, automatic control, and remote operation, with alarms, indications, switches, push buttons, audio signal, suitable for tripping andsignalling.

iii) Required number of fire detectors to be located in strategic locations to be finalized during detailed engineering. Fire detectors shall have minimum IP-67 class degree of protection.

iv) All controls, alarms, panels, cables, cable trays (if required), junction boxesetc.

v) Flow sensitive conservator Isolation valve to isolate the conservator oil from the main tank is being provided by the transformer supplier. This valve shall be located in the piping between the conservator and the Buchholz relay.

6. Under Ground Oil Storage Tank

Each transformer unit shall be provided with an underground oil storage tank. The oil storage tank shall have non-Corrosive, waterproof, epoxy coated (from Inside) mild steel (minimum thickness 5mm) to store drained out oi lon operation of NIFPS.The tank shall be painted from outside as per table below:

Painting	**Surface preparation**	**Primer coat**	**Intermediate undercoat**	**Finishcoat**	**Total dry film thick-ness (DFT)**	**Colour shade**
Oil Storage Tank	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40μm)	Epoxy high build Micaceous iron oxide (HB MIO) (75μm)	Aliphatic polyurethane (PU) (Minimum50μm)	Minimum 155μm	RAL 7035

Note: (*) indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501Part-1.

The total capacity of storage tank shall be at least 10% of transformer tank oil to avoid overflowing of oil considering that drained oil volume shall be around 10% of transformer tank oil. Necessary arrangement shall be made on underground storage tank so as to take out the drained oil from the tank for further processing and use. All the pipe and physical connection from transformer to oil pit shall be in the scope ofcontractor.

This storage tank shall be placed in the pit made of brick walls with PCC (1:2:4) flooring with suitable cover plates to avoid ingress of rainwater. The design of tank and pit shall befinalised during detailed engineering.

7. The entire test set up shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over thesystem.

8. Installation and pre-commissioning test After installation the system pre-commissioning tests shall be carried out jointly with the Owner’s representative before the system is put inservice.

ANNEXURE-S
Oil sampling bottles

Oil sampling bottles (if specified in BPS) shall be suitable for collecting oil samples from Transformers and shunt Reactors, for Dissolved Gas Analysis. Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

Oil sampling bottles shall be made of stainless steel having a capacity of 1litre. Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

The scope of oil sampling bottles shall be included in the bid price as per the quantity indicated in the bid price schedule.

Oil Syringe

If specified in BPS, the glass syringe of capacity 50ml (approx.) and three ways stop cock valve shall be supplied. The syringe shall be made from Heat resistant borosilicate Glass. The material and construction should be resistant to breakage from shock and sudden temperature changes, reinforced at luer lock tip Centre and barrel base.

The cylinder-Plunger fitting shall be leak proof and shall meet the requirement of IEC- 60567. Plunger shall be grounded and fitted to barrel for smooth movement with no back flow. Barrel rim should be flat on both sides to prevent rolling and should be wideenough for convenient fingertip grip. The syringe shall be custom fit and uniquely numbered for matching. The syringe shall be clearly marked with graduations of 2.0 ml and 10.0 mland shall be permanently fused for life time legibility.

ANNEXURE - T
Oil Storage Tank

1. Oil storage tank shall be of minimum capacity (as per BPS) along with complete accessories. The oil storage tank shall be designed and fabricated as per relevant Indian Standards e.g., IS 10987 (1992) or BS 2594. Transformer oil storage tanks **shall be towable on pneumatic tyres** and rested on manual screw jacks of adequate quantity & size. The tank shall be cylindrical in shape and mounted horizontally and made of mild steel plate of thickness as per standard. Diameter of the tank shall be 2.0 meter approximately. The tank shall be designed for storage of oil at a temperature of100 deg C.
2. Themaximumheightofanypartofthecompleteassemblyofthestoragetankshallnotexceed 4.0 metres above road top.
3. The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatictyres.
4. The tank shall also be fitted with manhole, outside & inside access ladder, silica gel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. The engine capacity in horse power to pull one tank completely fitted with oil shall be indicated. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the

tank. Solenoid valve (Electro-mechanically operated) with Centrifugal pump shall be provided at bottom inlet so that pump shall be utilised both ways during oil fill up and draining. Suitable arrangement shall also be provided to prevent overflow and drain form thetank.

5. Each tank shall be thoroughly cleaned internally of all loose matter and then tested to a pressure of 0.7 bar, measured at the top of the tank as per standard. Tank shall also be tested at internal vacuum of 10 mbar.
6. The following accessories shall also form part of supply along with each Oil storage tank.

7.1 Four numbers of 50 NB suitable rubber hoses for Transformer oil application upto temperature of 100 deg. C, full vacuum and pressure up to 2.5 Kg/ cm2 with couplers and unions each not less than 10 metre long shall be provided.

7.2 Two numbers of 100NB suitable for full vacuum without collapsing and kinking vacuum hoses with couplers and unions each not less than 10 metre long shall also be provided.

7.3 One number of digital vacuum gauge with sensor capable of reading upto 0.001 torr, operating on 240V 50Hz AC supply shall be supplied. Couplers and unions for sensor should block oil flow in the sensor. Sensor shall be provided with at-least 8-meter cable so as to suitably place the Vacuum gauge at ground level.

7.4 The painting of oil storage tank and its control panel shall be as per technical specification.

7.5 The tank shall contain a self-mounted centrifugal oil pump with inlet and outlet valves, with couplers-suitable for flexible rubber hoses and necessary switch gear for its control. There shall be no rigid connection to the pump. The pump shall be electric motor driven, and shall have a discharge of not less than 6.0 kl/hr. with a discharge head of 8.0m. The pump motor and the control cabinet shall be enclosed in a cubicle with IP-55enclosure.

ANNEXURE – U

Condition Controlled Maintenance Free Type Breather

1. The main Transformer tank conservator shall be fitted with a Maintenance-Free type silica gel Breather which shall be equipped with a microprocessor control unit and LED status indication.

2. *Dehydrating breather's operatingprinciple:*

When the oil conservator breaths-in (e.g., at reduced load), the air flows through a filter made of high-grade steel wire mesh. The equipment fitted with filter & the dust cap, filters the dust, sand and other dirt particles from the air. The filtered air flows through the desiccant chamber filled with colorless, moisture adsorbing pellets and are dehydrated. The dehydrated air rises further via the pipe in the oil conservator. The desiccant is dehydrated by the built-in heating unit which is controlled by sensors, thus obviating the need for periodic desiccant replacement. The dehydrating breather is mounted on the pipe to the oil conservator at a height of 1200 mm approximately from transformer rail top level.

3. TechnicalFeatures:

3.1 Material & External Construction of the Breather shall be such that all external parts are suitable for outdoor use & resistive to transformer oil, ultraviolet rays, pollution & salt water and shall work without any trouble for ambient temperature between 0o C to +80oC.

3.2 Following LEDs for local display on control unit, and suitable contacts & analog signal shall be provided for wiring to remote location:

a) LED for Power of control unit -ON
b) LED for Filter heater-ON
c) LED for Anti-condensation heater (of control unit) -ON
d) LED & relay contact for “DeviceError”
e) LED & relay contact for Regeneration active (De-humidification inprocess)
f) Analogue output signal (4-20mA) for the Temperature of air (in filter unit / pipe).

3.3 TheBreathershallbeequippedwithtestbuttonwhichshouldallowtocarryoutaself-testand to check the functions like relay circuits, heating or the signal transmission in the control room, etc. at anytime.

3.4 Control unit shall be equipped with a communication port for downloading the operational data logged by the unit. All necessary software required for downloading and analysing the logger data shall also be provided by the supplier. Supply of Laptop/PC for above software is not envisaged.

3.5 The moisture and temperature measurement system (sensor) installed should be modular making it easy to replace the same if at all the same is necessary during the service of breather.

3.6 The equipment shall operate at input supply of 230V AC, 50 Hz. Any converter if required shall be supplied with the equipment.

3.7 Degree of Protection shall be at least IP55 for which type Test report shall be submitted. Necessary protective devices shall be provided in order to protect the equipment against over voltages & high-frequency interference.

3.8 The control unit shall be equipped with suitable heater to prevent moisture condensation.

3.9 The size of Condition controlled maintenance free dehydrating breather shall be decided based on the volume of transformer oil during detailed engineering.

3.10 The equipment shall be covered on warranty for a period of 5 years from the last date of complete commissioning and taking over. During this period, if the equipment needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of, spares, software, transportation etc. of this equipment for repair at test lab/works. Further supplier shall make alternate arrangement for smooth operation of the transformer.

3.11 Condition Controlled Maintenance Free Type Breather of alternate proven technology shall also be acceptable.

Annexure-V

LIST OF CODES/STANDARDS/REGULATIONS/PUBLICATIONS

A list of Codes/Standards/Regulations/Publications which shall be used for design review, manufacturing, testing, erection, transportation etc. has been given below. In, case of revision/amendment of these, revised/amended versions shall be followed.

IS2026:Part1:2011 (Reaffirmed Year:2016)	-	Power transformers: Part1 General
IS2026:Part2:2010 (Reaffirmed Year:2020)	-	Power transformers Part2 Temperature-rise
IS2026:Part3:2018	-	Power TransformersPart 3 Insulation Levels, Dielectric Tests and External Clearances in Air (Fourth Revision)
IS2026:Part4:1977 (ReaffirmedYear:2016)	-	Power transformers: Part 4 Terminal marking, tappings and connections
IS2026:Part5:2011 (ReaffirmedYear:2016)	-	Power Transformers Part 5 Ability to Withstand Short Circuit
IS2026:Part6:2017	-	Power Transformers Part6 Reactors
IS2026:PART7:2009 (ReaffirmedYear:2019)	-	Power Transformers Part7 Loading Guide for Oil-Immersed Power Transformers
IS2026:Part8:2009 (ReaffirmedYear:2019)	-	Power Transformers: Part8 Applications guide
IS2026:Part10:2009 (ReaffirmedYear:2019)	-	Power Transformers: Part10 Determination of soundlevels
IS2026: Part 10: Sec1: 2018	-	PowerTransformerspart10 DeterminationofSoundLevelsSection1Applicationguide
IS2026:Part14:2018	-	PowerTransformersPart14 Liquid-ImmersedPowerTransformersUsingHigh-TemperatureInsulationMaterials
IS2026:Part18:2018	-	PowerTransformersPart18MeasurementofFrequencyResponse
IEC 60076 All parts	-	Power Transformers
IS 3024: 2015	-	Grain Oriented Electrical Steel Sheet and Strip (Third Revision)
IS 8468: Part 1: 2018 IEC 60214-1: 2014	-	Tap-Changers Part 1 Performance Requirements and Test Methods (First Revision)
IEC / IEEE 60214- 2:2019		Tap-changers- Part 2: Application guidelines
IS 8478: 1977 (Reaffirmed Year: 2016)	-	Application guide for on-load tap changers
IS 649: 1997 (Reaffirmed Year: 2018)	-	Methods for testing steel sheets for magnetic circuits of power electrical apparatus
IS-10028 (Part 1, 2 & 3)	-	Code of practice for selection, installation & maintenance of transformer

IS 3639 : 1966 (Reaffirmed Year : 2016)	-	Fittings and Accessories for Power Transformers
IS 3637 : 1966 (Reaffirmed Year : 2016)	-	Gas Operated Relays
IS 335 : 2018	-	New Insulating Oils — Specification (Fifth Revision)
IEC 60296-2020	-	Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment
IEC 60422 : 2013	-	Mineral insulating oils in electrical equipment - Supervision and maintenance guidance
IS 6792 : 2017	-	Insulating Liquids - Determination of the Breakdown Voltage at Power Frequency - Test Method (Second Revision)
IS/IEC 60137 : 2017	-	Bushings for alternating voltagesabove 1000 Volts
IS 12676 : 1989 (Reaffirmed Year : 2016)	-	Oil Impregnated Paper Insulated Condenser Bushings - Dimensions and Requirements
IS 4257 : Part 1 : 1981 (Reaffirmed Year : 2019)	-	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings - Part I : For 12 kV to 36 kV Bushings
IS 4257 : Part 2 : 1986 (Reaffirmed Year : 2019)	-	Dimensions for clamping arrangements for porcelain transformer bushings: Part 2 For 72.5 kV and 123 kV bushings
IS 8603 : 2008 (Reaffirmed Year : 2019)	-	Dimensions for porcelain transformers bushings for use in heavily polluted atmospheres 12/17.5kV, 24kV and 36kV
IS 8603 : Part 4 : 2003 (Reaffirmed Year : 2019)	-	Dimensions for Porcelain Transformer Bushings for Use in Heavily Polluted Atmospheres - Part 4 : 52 kV Bushings
ANSI-C57.12.80	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C57.12.90	-	Test Code for Distribution, Power and Regulation Transformers
NEMA-TR-1	-	Transformers, Step Voltage Regulators and Reactors
IS 1747 : 1972 (Reaffirmed Year : 2016)	-	Nitrogen
IS-5: 2007	-	Colours for Ready Mixed Paints and Enamels
IS 3043 : 2018	-	Code of Practice for Earthing
IS 8263 : 2018	-	Radio Interference Test on High -Voltage Insulators (First Revision)
IS 8269 : 1976 (Reaffirmed Year : 2014)	-	Methods for switching impulse tests on high voltage insulators
IS 2071 : Part 1 : 2016	-	High-voltage Test Techniques Part 1 General Definitions and Test Requirements (Third Revision)
IS 16803 : 2018	-	High Voltage Test Techniques - Measurement of Partial Discharges by Electromagnetic and Acoustic Methods

IS/IEC 60270 : 2000 (Reaffirmed Year : 2016)	-	High — Voltage Test Techniques — Partial Discharge Measurements
IS 13235 : Part 1 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 1 Definitions and Calculation Methods (First Revision)
IS 13235 : Part 2 : 2019	-	Short-Circuit Currents — Calculation of Effects Part 2 Examples of Calculation (First Revision)
IS 16227 : Part 1 : 2016 IEC 61869-2 : 2007	-	Instrument Transformers: Part 1 General requirements
IS 16227 : Part 2 : 2016 IEC 61869-2 : 2012	-	Instrument Transformers Part 2 Additional Requirements for Current Transformers
IS 16227 : Part 100 : 2018	-	Instrument Transformers Part 100 Guidance for Application of Current Transformers in Power System Protection
IS/IEC 60529 : 2001 (Reaffirmed Year : 2019)	-	Degrees of protection provided by enclosures (IP CODE)
IS/IEC-60947	-	Low voltage switchgear and control gear
IS 2062 : 2011 (Reaffirmed Year : 2016)	-	Hot Rolled Mediumand High Tensile Structural Steel
IS 9595 : 1996 (Reaffirmed Year : 2019)	-	Metal arc welding of carbon and carbon manganese steels - Recommendations
IS 10801 : 1984 (Reaffirmed Year : 2016)	-	Recommended procedure for heat treatment of welded fabrications
IS 4253 : Part 1 & 2 : 2008 (Reaffirmed Year: 2019)	-	Cork Composition Sheets
IS 11149 : 1984 (Reaffirmed Year : 2019)	-	Rubber Gaskets
IS 12444 : 1988 (Reaffirmed Year : 2015)	-	Continuously cast and rolled electrolytic copper wire rods for electrical conductors
IS 513 : 2016	-	Cold Reduced Carbon Steel Sheet and Strip
IS 12615 : 2018	-	Line Operated Three Phase A.C. Motors (IE CODE) "Efficiency Classes and Performance Specification" (Third Revision)
IS/IEC 60034 : PART 5 : 2000 (Reaffirmed Year : 2018)	-	Rotating electrical machines: Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP CODE) - Classification
IS 5561 : 2018	-	Electric Power Connectors- Specification
IS 2932 : Part 1 : 2013 (Reaffirmed Year : 2018)	-	Enamel, Synthetic, Exterior: (a) Undercoating (b) Finishing - Specification: Part 1 for Domestic and Decorative Applications
IS 2074 : Part 1 : 2015	-	Ready Mixed Paint, Air Drying, Red Oxide - Zinc Chrome, Priming - Specification
IS 3400	-	Methods of Test for Vulcanized Rubber
IS 456 : 2000 (Reaffirmed Year : 2016)	-	Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3, & 4)
IS 13238 : 1991	-	Epoxy Based Zinc Phosphate Primer (two Pack)

(Reaffirmed Year : 2017)		
IS 2848 : 1986 (Reaffirmed Year : 2016)	-	Industrial Platinum Resistance Thermometer Sensors
IS/IEC 61850	-	Communication Networks and Systems for Power Utility Automation
IS 16683 : Part 1, 2 & 3 : 2018	-	Selection and Dimensioning of High Voltage Insulators Intended for Use in Polluted Conditions
IEEE 1538-2000		Guide for determination of maximum winding temperature rise in liquid filled transformers
IEEE Standard C57.156- 2016		Guide for tank rupture mitigation of oil immersed transformers
IEEE Standard C57.150- 2012		Guide for Transformer Transportation
IEEE Standard C57.149- 2012		Guide for the application and interpretation of FrequencyResponseAnalysisof oil immersed transformers
IEEE Standard C57.104- 2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
IEC 60599-2015		Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. C57.12.10 - 2017		Standard requirements for liquid immersed power transformers
IEEE Std. 57.104-2019		Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
IEC 60599		Mineral oil-filled electrical equipment in service – Guidance on the interpretation of dissolved and free gases analysis
IEEE Std. 62-1995		Guide for Diagnostic Field Testing of Electric Power Apparatus - Part 1: Oil Filled Power Transformers, Regulators, and Reactors
CIGRE Technical Brochure No. 529 -2013		Guide lines for conducting design reviews for Power Transformers
CIGRE Technical Brochure No. 673-2016		Guide on Transformer Transportation
CIGRE Technical Brochure No. 530-2013		Guide for conducting factory capability assessment for Power Transformers
CIGRETechnicalBrochure No.761 (WG A2.49)		Condition assessment of power transformers
CIGRE TB 209		Short Circuit Performance of Power Transformers
CIGRE TB 436		Experiences in service with new insulating liquids
Central Electricity Authority (MeasuresRelatingtoSafetyandElectricSupply)Regulations		
Central Electricity Authority (Technical Standard for Construction of Electrical Plants and Electric Lines) Regulations		
Central Electricity Authority (Installation and Operation of Meters)Regulations		
CBIP Manualon Transformers (PublicationNo.317)		

ISO	9001: Quality System – Model for Quality Assurance inDesign/Development.
ISO-14001(Environmental Management System)	
OHSAS18001(Occupational Health and Safety Management System)	

Annexure-W

BASIC MANUFACTURING FACILITY & MANUFACTURING ENVIRONMENT

Customer/Purchaser always desires that transformer/reactor manufacturedand delivered is of good quality and must perform trouble free service for its “Specified Design Life”. The consistency in quality of material used & manufacturing process are main cause for variation in quality of transformer/reactor. It is also equally very important that transformer/reactor is manufactured in a clean dust free and humidity-controlled environment. Any compromise on this aspect will have adverse effect in expected design life of transformer/reactor, however good is the quality of material used. Abroad list of facilities the transformer/reactor manufacturers should have are givenbelow:

Basic manufacturing facility

Following manufacturing facility should be available for use with transformer and reactor manufacturer:

1. EOT Crane for main manufacturing bay and other shops (With Load Cell).
2. Vapor Phase Drying Oven (adequately sized to accommodate offered transformer and have facility to record temperature, vacuum, moisture etc.)
3. Air Casters for material handling
4. Core cutting line (If applicable)
5. Vacuum auto claves
6. Air oven
7. Adjustable Horizontal and vertical winding machine
8. Winding Mandrels
9. Hydraulic Press
10. Brazing equipment
11. Mechanica lplatform
12. Tools and fixtures
13. Mechanical power press
14. Welding machines
15. Crimping tools
16. Faraday’s cage
17. Motor Generator Set/Static Power SystemS et
18. Testing transformer
19. Capacitor bank
20. Impulse voltage generator
21. Capacitance & Tan delta bridge
22. Power Analyzer
23. Current & Voltage transformer
24. Partial Discharge (PD)measuring kit (for all manufacturers) & PD Diagnostic Kit (for 400kV & above voltage class Transformer/reactor manufacturer)

25. Temperature data logger
26. Noise measurement kit
27. Thermovision camera
28. Loss measurement kit
29. Insulation tester
30. Winding resistance meter
31. Turn ratio meter
32. Transformer oil test lab
33. Dissolved Gas Analysis (DGA) test kit
34. Sweep Frequency Response Analyzer (SFRA)kit
35. Frequency Domain Spectroscopy (FDS)kit
36. NABL Accredited laboratory for testing
37. Oil Storage tanks
38. Oil filter plant with requisite level of vacuum and filter
39. Tenso meter for Oil Surface tension
40. Particle Count Kit (for 400kV & aboveTransformer/reactor)
41. Multimeters

Manufacturing environment (Clean, dust free and humidity-controlled environment)

A. Transformer must be manufactured in a bay having positive pressure w.r.t. external environment. Winding shall be manufactured in a clean, dust free and humidity-controlled environment. The dust particle shall be monitored regularly in the manufacturing areas. Further, thereshall be positive atmospheric pressure, clean, dust free and humidity-controlled environment for following:

1. Insulation storage
2. Core storage
3. Glue stacking area
4. Core cutting line
5. Winding manufacturing bay
6. Core building area
7. Core coil assembly area
8. Testing lab
9. Packing & dispatch area

B. Following accessories to be kept in clean and covered location:

1. Piping
2. Radiator
3. Tank
4. Bushing (as per manufacturer's guideline)
5. Marshalling box
6. Turret
7. Conservator
8. Insulating oil

Schedule-1

List of drawings to be submitted by successful bidder for approval of theProject&DesignDepartment	
Sr. No.	**Particulars of Drawing**
1	General Arrangement (with provision of pockets for PT-100 sensors for remote /SCADA oil
	& Winding Temperature Indications) Overall dimensions to be restricted as per Clause 5.3
2	List of fittings as per G.A.
3	Rating and diagram plate (additional information such as Guaranteed /Measured losses;
	Guaranteed /Measured impedances at extreme and normal taps; Guaranteed /Measured
	Temperature rises for oil & winding; Core weight; Copper weight and Core & winding weight
	shall be invariably mentioned)
4	Over loading plate
5	Valve Schedule Plate
6	Foundation Plan
7	Transport Outline
8	H.V. Bushing
9	I.V. Bushing (as per requirement)
10	L.V. Bushing
11	Neutral Bushing
12	Terminal connector for
	I) HV
	ii) I.V. (as per requirement)
	iii) LV.
	iv) Tertiary (as per requirement)
13	Neutral Grounding bar Assembly
14	L.V. grounding Assembly
15	Conservator Tank.
16	Magnetic Circuit Earthing Details
17	Equalizing Pipe arrangement.
18	Oil filling Instruction plate
19	OLTC shaft connection diagram.
20	OLTC equalizing Pipe arrangement
21	General Arrangement of RTCC
22	OLTC Schematic with group simultaneous mode of control. Connectivity for tap raise -lower
	operations and Tap Position Indication through SCADA & TMCTS
23	OLTC legend
24	Schematic wiring for RTCC panel
25	RTCC legend
26	Radiators.
27	General Arrangement of Cooling Control Cabinet
28	Cable termination plan (Co-ordination) between OLTC & RTCC
29	Schematic for Facia Annunciator
	Schematic wiring for cooler control comprising
	i) Cooler control legend
	ii) Main and standby supply circuit alongwith heater and lighting circuit
	iii) Power circuit for Fans Gr. I, Gr. II & Standby
	iv) Control circuit for Fans Gr. I, Gr. II & Standby

	v) Power circuit for pumps Gr. I, Gr. II and Standby (as per requirement)
	vi) Control circuit for Pumps Gr. I, Gr. II, (as per requirement)
	vii) Lamp indication circuit
	viii) Annunciation Circuit
	ix) Oil & Winding Temperature Local indicating circuit / Alarm & Trip circuit for oil temp and winding temperature.
	x) Alarm & Trip Circuit (for MOG, PRV, Main Buchholz & OLTC Buchholz
	xi)) Wiring diagram of PT - 100 (for remote / SCADA WDG Temp. and Oil Temp. Indication)
	xii) Cable Termination Plan (Co-ordination) between a) FCC to RTCC
	b) FCC to OLTC
	c) FCC to C&R Panel
	xiii) Notes & Instructions
	xiv) REF Protection CT circuit.
30	Schematic wiring for TMCTS
31	General arrangement of optic fibre temperature measurement system. GA of Monitor Box and its schematic wiring diagram
32	General arrangement of on-line multi gas DGA for transformer oil and its schematic wiring diagram (as per requirement)
33	General arrangement of Condition controlled (Maintenance Free) Regenerating Silica Gel Breather for transformer oil (as per requirement)
34	Cable schedule
35	Roller Assembly
36	N2 Injection fire protection system drawing with Bill of material. (As per requirement)
37	HVWS fire protection system drawing with Bill of material. (As per requirement)
38	GTP for approval
39	Complete Bill of Materials.
40	QAP
41	Type Test Report conducted on identical transformer within last 5 years (if any)
42	I^2R calculations
43	Impedance calculations
44	Short circuit calculations
45	Cooling calculations
46	Core cutting schedule (Core shall be cut at Mill’s authorised processing unit only)

Schedule-2
Details of Loss Calculation
(To be filled in by the Bidder)

Sl. No	Particulars	Values
1.	Flux density at	
	(i) (145/36, 245/145, 245/145/36, 420/245) kV & 48.5 Hz, Tesla	
	(ii) (132/33, 220/132/33, 220/132, 132/33) kV & 50 Hz, Tesla.	
2.	Core Data	
	(i) Core weight in Kg.	
	(ii) Gross core area [mm²]	
	(iii) Stacking factor.	
	(iv) Net core iron area [mm²] [ii x iii]	
3.	Specific losses [W/Kg.]	
	(i) At maximum flux density corresponding to (145/36, 245/145, 245/145/36, 420/245) KV and 48.5 HZ.	
	(ii) At maximum flux density corresponding to (132/33, 220/132/33, 220/132, 132/33) KV and 50Hz.	
4.	Volt ampere/Kg	
	(i) At maximum flux density corresponding to (145/36, 245/145, 245/145/36, 420/245) KV and 48.5 HZ.	
	(ii) At maximum flux density corresponding to (132/33, 220/132/33, 220/132, 132/33) KV and 50Hz.	
5.	Calculated/guaranteed iron loss in KW at:	
	(i) Rated voltage and rated frequency	
	(ii) Rated voltage and rated frequency	
6.	Current density [A/Sq. mm] for	
	(i) HV	
	(ii) LV	
7.	Conductor size [in mm²]	
	(i) HV winding	
	a) Bare	
	b) Insulated	
	c) No of conductors in parallel	
	(ii) LV winding	
	a) Bare	
	b) Insulated	
	c) No of conductors in parallel	
8.	Copper weight	
	(i) H.V. windings	
	(ii) LV windings	
	(iii) For Tap connections,	
	(iv) Total copper weight [i]+[ii]+[iii]	
9.	L.V. winding resistance in ohms at 75°C/Phase.	
10.	H.V. winding resistance in ohms at 75°C/Phase.	
	(i) At normal tap position	
	(ii) At maximum tap position	

Sl. No	Particulars	Values
	(iii) At minimum tap position	
11.	Stray losses and eddy current losses [in KW] at 75°C	
	(i) At normal tap position	
	(ii) At maximum tap position	
	(iii) At minimum tap position	
12.	Resistively of copper to be used for winding	
13.	I^2R loss at 75°C	
	(i) At normal tap position	
	(ii) At maximum tap position	
	(iii) At minimum tap position	
14.	Calculated guaranteed copper losses [in KW] at 75°C [I^2R] loss + stray losses]	
	(i) At normal tap position	
	(ii) At maximum tap position	
	(iii) At minimum tap position	
15.	Guaranteed Auxiliary loss	
16.	Computed/guaranteed total loss in KW at rated voltage and rated frequency	
	(i) At normal tap position	
	(ii) At maximum tap position	
	(iii) At minimum tap position	

NB: - 1. Approximate values in weight and losses etc. are not allowed.
2. Tolerance of + 5% in weights may be quoted without any approximation

Place:
Date:

Bidder’s name:
Signature, designation, seal

Schedule-3

Maximum Flux Density and Core Weight Calculation

(To be filled in by the Bidder)

Step No	Width of steps [mm]	Stack Thickness [mm]	Gross Iron Area [mm^2]
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Bmax = **E/ (4.44 x f x Ai x N)**

Where, E = L.V. winding phase voltage / phase
f = Rated frequency = 50 HZ.
Bmax. = Maximum flux density in Tesla.
Ai = Net iron area in sq. m = Gross iron area x stacking factor in sq. m
N = Number of L.V. winding, turns/phase
Stacking Factor = 0.97 maximum

Core weight calculation: -
Core dia [in mm] =
Window height [in mm] = Limb centre [in mm] =
Weight of core = [3 x window height + 4 x limb centre + 2 x max. width] x Net iron area x Density of core
NB: -
1 Specific loss vs. flux density graph for the type of core lamination to be used has to be furnished.
2. VA/Kg. Vs flux density graph for the core lamination to be used has to be furnished.
3. Any other factor assumed for above calculation to be explained with reasons.

N.B: -The bidder may use its own method of calculation towards determination of maximum flux Density and weight of the core. But the same shall be supported with proper explanation and Justification.

Place:
Date:

Signature of Bidder
With seal of Company.

Schedule-4

Manufacturer Quality Plan (MQP)

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
1.0	**MATERIAL**							
1.1	**Copper Conductor**							
1.1.1		Sample check on winding conductor for electrical conductivity	Testing	Sampling/lot	TM Spec	Insp.rec ord	Vendor/TM QC	CHP at Vendor end
1.1.2		Dimensions Width & Thickness (Bare) & Visual for scratches, dentarks	Measurem ent	-Do-	TM Spec	-Do-	-Do-	CHP at Vendor end
1.1.3		Sample check on insulating paper for pH value, electric strength	Testing	-Do-	TM Spec	-Do-	-Do-	TC Review
1.1.4		check for bonding of the insulatingpaper with conductor	Visual	-Do-	TM Spec	-Do-	-Do-	CHP at Vendor end
1.1.5		Check for the reaction of hot oil andinsulating paper	Testing	-Do-	TM Spec	-Do-	-Do-	TC Review
1.1.6		Check & ensure that physical condition of all materials taken for winding is satisfactory and dust free.	Visual	-Do-	TM Spec	-Do-	-Do-	CHP at Vendor end
1.2	**Core Material**							
1.2.1		Sample testing of core materials for checking specific core loss, properties, magnetization characteristics& Thickness	Testing	Sampling/l ot	TM Spec	Insp.rec ord	Vendor/TM QC	CHP at Vendor end

1.2.2		Amount of burr	Measurement	-Do-	-Do-	-Do-	-Do-	CHP at Vendor end
1.3	**Insulating Material**							
1.3.1		Physical Properties	Testing	Sampling/lot	TM Spec	Insp.record	Vendor/TM QC	TC Review
1.3.2		Dielectric	Testing	Sampling/l	TM Spec	Insp.record	Vendor/TM	TC

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
		Strength		ot		ord	QC	Review
1.3.3		Reaction of hot oil on insulating materials	Testing	Sampling/lot	TM Spec	Insp.record	Vendor/TM QC	TC Review
1.4	**OIL**							
1.4.1		Appearance	Visual	Sampling	IS 335/TM Spec	Insp Record	Vendor/TM QC	CHP at Vendor end
1.4.2		Density	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.3		Viscosity	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.4		Interfacial tension	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.5		Neutralisation Value	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.6		Dielectric strength	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.7		Tan Delta	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.8		Specific Resistance	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.9		Water content	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.10		Flash point	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.11		Pour point	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.12		Corrosive sulphur	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.13		Oxidation stability (a)Neutralization after oxidation (b)Total sludge after Oxidation	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.14		Ageing characteristics after accelerated ageing	Testing	-Do-	-Do-	-Do-	-Do-	
1.4.15		Presence of oxidation	Testing	-Do-	-Do-	-Do-	-Do-	

		Inhibitor						
1.4.16		SK value	Testing	-Do-	-Do-	-Do-	-Do-	
2.0	**FITTINGS AND ACCESSORIES**							
2.1	Tank & Conservator Raw material							
2.1.1		Type of material	TC Verif	Sampling	TM Spec	Insp Record	Vendor/TM QC	
2.1.2		Thickness	Testing	-Do-	-Do-	-Do-	-Do-	CHP at Vendor end
2.2	**Tank & conservator Assembly**							
2.2.1		Inspection of major welds.	Visual	Each Unit	TM Spec	Insp Record	Vendor/TM QC	CHP at Vendor end
2.2.2		NDT for load bearing(Jacking pad, liftingbollard)	Testing	Each Unit	TM Spec	Insp Record	Vendor/TM QC	CHP at Vendor end
Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Recod	Inspection Agency	Remarks
		Welds(DP test)						
2.2.3		dimensions between wheels, demonstrate turning of wheels through 90 deg. & further dimensional check	Testing	Each Unit	TM Spec	Insp Record	Vendor/TM QC	CHP at Vendor end
2.2.4		Leakage Test of conservator	Testing	Each Unit	TM Spec	Insp Record	Vendor/TM QC	CHP at Vendor end
2.2.5		Measurement of film thickness of	Testing	Each Unit	TM Spec	Insp Record	Vendor/TM QC	CHP at TM for total DFT measurement during final inspection
		(i) Zinc chromate paint	Meas	-Do-	-Do-	-Do-	-Do-	
		(ii) Finished coat	Meas	-Do-	-Do-	-Do-	-Do-	

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
2.2.6		-Pressure &Vacuum test	One unit/Rating	-Do-	-Do-	-Do-	-Do-	CHP at Vendor end
2.3	**Radiator**							
2.3.1		Visual&Dimension	Measurement	Each Unit	TM Spec	Insp Record	Vendor/TM QC	
2.3.2		Pressure test & leakage test	Testing	-Do-	-Do-	-Do-	-Do-	
2.3.3		Paint thickness	Measurement	-Do-	-Do-	-Do-	-Do-	
2.4	**Marshalling box & RTCC**							
2.4.1		Dimension (WxDxHof panel)	Measurement	Each Unit	TM Spec	Insp Record	Vendor/TM QC	
2.4.2		Meas. of 2 kV dielectric test	Testing	-Do-	-Do-	-Do-	-Do-	CHP
2.4.3		Component make & Rating	Visual	-Do-	-Do-	-Do-	-Do-	
2.4.4		Completeness, label Fixing & finishing	Visual	-Do-	-Do-	-Do-	-Do-	
2.4.5		Functional test	Visual	-Do-	-Do-	-Do-	-Do-	
2.4.6		IP:55 test for M. Box	Testing	1 unit/rating	IS 2147	-Do-	-Do-	CHP
2.5	**Temperature indicators (OTI, WTI)**							
2.5.1		Type	Visual	Each Unit	TM Spec	Insp Record	Vendor/TM 's QC	
2.5.2		Continuity check	Manual	-Do-	-Do-	-Do-	-Do-	
2.5.3		Switch setting & calibration	-Do-	-Do-	-Do-	-Do-	-Do-	
2.6	**Buchholz Relay**							
2.6.1		Type/Model	Visual	-Do-	-Do-	-Do-	-Do-	
2.6.2		Continuity of Contacts	Manual Check	-Do-	-Do-	-Do-	-Do-	
2.6.3		Operation of contacts	Manual Check	-Do-	-Do-	-Do-	-Do-	
2.7	**Bushings**							
2.7.1		Test for leakage on	TC Verify	Each Unit	IS 2099/TM	Insp	Vendor/TM	
		internal fillings (Tightness test)			Spec	Record	's QC	
2.7.2		Dry power frequency test on terminal & tapping	TC Verif	Each Unit	IS 2099/TM Spec	Insp Record	Vendor/TM 's QC	

2.7.3		Measurement of dielectric dissipation factor& capacitance	TC Verif	Each Unit	IS 2099/TM Spec	Insp Record	Vendor/TM 's QC	
2.7.4		Partial discharge test followed by dielectric dissipation factor &capacitance measurement for condenser bushings &creepagedist ance measurement.	Testing	Each Unit	IS 2099/TM Spec	Insp Record	Vendor/TM 's QC	CHP at Vendor end
2.8	**Current Transformers**							
2.8.1		Type & finish	Visual	Each lot	TM's Spec	Insp Record	Vendor/TM 's QC	
2.8.2		Dimensions (OD, ID & H)	Measur	Each Unit	-Do-	-Do-	-Do-	
2.8.3		Verification of Terminal Marking& Polarity	Testing	Each Unit	-Do-	-Do-	-Do-	
2.8.4		P.F.dry withstand test	-Do-	-Do-	-Do-	-Do-	-Do-	
2.8.5		Overvoltage interturntest	-Do-	-Do-	-Do-	-Do-	-Do-	
2.8.6		Determination of errors	-Do-	-Do-	-Do-	-Do-	-Do-	
2.9	**Pressure relief Valve/Sudden pressure relay**							
2.9.1		Type/ Model	Visual	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.9.2		Manual operation of Switch contacts	Manual Check	-Do-	-Do-	-Do-	-Do-	
2.9.3		Operating pressure	Testing	-Do-	-Do-	-Do-	-Do-	
2.10	**MOLG**							
2.10.1		Type/ Model	Visual	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.10.2		Dial Calibration	TC Verif	-Do-	-Do-	-Do-	-Do-	
2.10.3		Switch Continuity	Manual Check	-Do-	-Do-	-Do-	-Do-	
2.11	**Valves**							
2.11.1		Type & Size	Visual	Each Unit	Customer Spec	Insp Record	Vendor/TM 's QC	
2.11.2		Open & shut marking	-Do-	-Do-	-Do-	-Do-	-Do-	
2.11.3		Leakage test	TC Varif					
2.12	**Silica gel breather**							

2.12.1		Type/ Model	Visual	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.13	**Online H_2& Moisture monitoring**							
2.13.1		Type / Model	Visual	Each Unit	TMs Spec	Insp	Vendor/TM	

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
						Record	's QC	
2.14	**Tap changer**							
2.14.1		Type & Rating	Visual	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.14.2		Physical condition	Visual	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.14.3		Mechanical Operation Check	Testing	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.14.4		Insulation Resistance Test	Testing	Each Unit	TMs Spec	Insp Record	Vendor/TM 's QC	
2.15	**Cooling fan**							
2.15.1		HV test	Testing	Each Unit	IS 2312	Insp Record	Vendor/TM 's QC	
2.15.2		Insulation Resistance Test	-Do-	-Do-	-Do-	-Do-	-Do-	
2.15.3		Performance Test	-Do-	-Do-	-Do-	-Do-	-Do-	
2.15.4		DFT of Galvanization on Fanguard	-Do-	-Do-	TM's Spec	-Do-	-Do-	
3.0	**MANUFACTURING**							
3.1	**Assembled Core**							
3.1.1		Visual & dimensionalcheck during assembly stage	Visual/ Meas	Each Assembly	TM's Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works
3.1.2		Check on completed core for measurement of iron loss	Meas/Testing	Each Assembly	Customer Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works
3.1.3		2KV H.V.test (Core insulation test) between Core &clamps for one minute And Insulation resistance test of core & clamps (clamps)	Testing	Each Assembly	Customer Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
3.1.4		Visual & dimensional checks for straightness &roundness of core, thickness oflimbs and suitability of clamps	Visual	-Do-	-Do-	-Do-	-Do-	CHP at TM's Works
3.2	**Wound Coils**							
3.2.1		Visual check for brazed joints wherever applicable	Visual	Sampling/L ot	TM's Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works
3.2.2		Visual check of insulation on the conductors & between the windings	Visual	Sampling/L ot	TM's Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works
3.2.3		Check for the absence of short circuit between parallel strands of PICC	Testing	-Do-	-Do-	-Do-	-Do-	CHP at TM's Works
3.3	**Coil & Core assembled**							
3.3.1		Active part before drying						
		(i) Visual check	Visual	Each Unit	TM's Spec	Insp Record	Vendor/TM 's QC	CHP at TM's Works
		(ii) Checkinsulationdistance between high voltage connections, between high voltageconnection cables & earth and other live parts	Meas	-Do-	-Do-	-Do-	-Do-	CHP at TM's Works
		(iii) Check insulating distance between low voltageconnections andearthandotherparts	Meas	-Do-	-Do-	-Do-	-Do-	CHP at TM's Works

		(iv) 2KV core insulationtest	Testing	-Do-	-Do-	-Do-	-Do-	CHP at TM's Works
3.3.2	Active part after drying							
		(i) Measurement& recording of temperature & drying time during vacuum treatment	VPD Data	Each Unit	TM's Spec	Insp Record	TM's testing/TM'sQC	**In process check card review by Custom e r**
		(ii) Check for completeness of drying	VPD Data	Each Unit	TM's Spec	Insp Record	TM's testing/TM'sQC	**In process check card review by Custom e r**
3.4	**Assembled Transformer**							
3.4.1		Check Completed transformeragainstap proved outline drawing, provision for all fittings, finish levels etc.	Visual	One Transform er of each rating	Approved GA drawing	Insp Record	TM's testing/TM'sQC	**CHP at TM's Works**
3.4.2		Jacking test	Visual	-Do-	-Do-	-Do-	-Do-	**CHP at TM's Works**
3.5	**Final Testing**							
3.5.1	**Routine Tests**							

Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
3.5.1.1		Winding resistance test	Testing	Each Unit	IS 2026/IEC 60076	Insp Record	Customer/ TM	**CHP at TM's Works**
3.5.1.2		Turn ratio, Polarity						
3.5.1.3		Vector group test and Phase vector relationship test						
3.5.1.4		Load loss & impedance voltage						

3.5.1.5		No-load loss and current measurement						
3.5.1.6		Measurement of magnetization current at low voltage.						
3.5.1.7		Insulation Resistance measurement						**CHP at TM's Works**
3.5.1.8		Separate source voltage withstandtestforallwindings (1 Minute)						
3.5.1.9		Induced over-voltage withstand test for 60 Sec. @ 100 Hz						
3.5.1.10		Full wave lightning impulse on three phases						
3.5.1.11		Measurement of partial dischargeat the time of induced over voltage test						
3.5.1.12		Frequency response analysis (FRA)						
3.5.1.13		Measurement of zero sequence impedance of three phase transformers.						
3.5.1.14		Measurement of acousticnoiselevel						
3.5.1.15		Measurement of the harmonicsof the no-load current						
3.5.1.16		Measurement of capacitance and ten δ to determine capacitance between winding and earth. Value of tanδ should notbe more than 0.5% at 20°C						

3.5.1.17		Oil leakage test on						
Sl No.	Component	Characteristics	Type of Inspection	Quantum of Inspection	Ref Doc & Acceptable Norm	Form of Record	Inspection Agency	Remarks
		transformer tank as per CBIP						
3.5.1.18		Test on OLTC						
3.5.1.19		Magnetic balance test						
3.5.2	**Type Test**							
3.5.2.1		Temperature-rise test with 2 x 50% radiator banks including DGA test after & before temp rise test	Testing	One Unit on each rating	IS 2026/IEC 60076	Insp Record	Customer/ TM	**CHP at TM's Works**
3.5.2.2		Measurement of the power taken by the fans						**CHP at TM's Works**
3.5.2.3		Pressure & Vacuum test on transformer tankas per CBIP						
3.6	**Pre-shipment check**							
3.6.1		Detach accessories for despatch	Visual	Each unit	TM's spec	Insp Record	TM	
3.6.2		Blanking of openings	-Do-	-Do-	-Do-	-Do-	-Do-	
3.6.3		Adjustment of oil Level/ Draining of oil	-Do-	-Do-	-Do-	-Do-	-Do-	
3.6.4		Finishing, cleaning & Painting touch up	-Do-	-Do-	-Do-	-Do-	-Do-	
3.6.5		Dew point measurement before despatch	Testing	-Do-	-Do-	-Do-	-Do-	**Reqd for only Transformer despatch without oil**
3.6.6		Gas tightness test to confirm tightness	Testing	-Do-	-Do-	-Do-	-Do-	

3.6.7		Check for proper packing of detached accessories for dispatch & Check for proper provision of bracing to arrest the movement of core & winding assembly inside the tank	Testing	-Do-	-Do-	-Do-	-Do-	

Note:

1. TM – Transformer Manufacturer
2. CHP – Customer Hold Point

SECTION – 5

TECHNICAL SPECIFICATION OF 33 KV INDOOR VACCUM CIRCUIT BREAKERS

5.1.0 SCOPE

This section of the specification covers the manufacture, testing at manufactures works, erection and commissioning of indoor 33 KV which includes 33 KV circuit breakers with current transformers, voltage transformers, local controls and instruments & meters etc. and wired complete with all accessories as specified.

5.2.0 STANDARDS

The switchgear panels shall comply in all respects the requirement laid down in the latest editions of IEC: 62271-200/100 unless otherwise specified in this specification.

5.3.0 TYPE & RATING

5.3.1 The panels 33 kV switchgear panels shall comprise of 33 kV Vacuum Type circuit breakers, instrument panels and instrument transformers etc. suitable for indoor use. The equipment shall be totally enclosed in a metal clad cubicle, dust and vermin proof with necessary isolation arrangement. Each panel shall be easily extensible on either side and should be complete with necessary internal copper connections, small wiring, L.T. fuses and supporting frame work with bolts to secure it to the floor. The Circuit Breakers shall be draw out type in horizontal position.

5.3.2 Principal parameters

The breakers shall have the following ratings:

a. Type: Vacuum
b. No of poles: 3
c. Nominal system voltage: 33 kV
d. Highest system voltage: 36 kV
e. Rated frequency: 50 +/- 1.5 Hz
f. Rated continuous current: 2500 Amp for incoming,1600 Amp rating at an ambient for outgoing feeders & 1600Amp for Bus Coupler (Bus Bar Rating=2500Amp).
g. Symmetrical breaking: 31.5 kA for 3 Sec.
h. Impulse withstand test voltage: 170 kV (Peak)
i. One-minute power frequency withstand test voltage: 70 kV (rms)
j. Short time current: Not less than 31.5 kA for 3 sec.
k. System neutral: Solidly earthed.

5.4.0 CONSTRUCTIONAL FEATURES

5.4.1 The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction, comprising of a row of freestanding floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, Main busbars and auxiliary control devices. The adjacent panels shall becompletely separated by steel sheets expect in busbar compartments where insulated barriersshall be provided to segregate adjacent panels. However, manufacturer's standard switchgear designs without internal barriers in busbar compartment may also be considered.

5.4.2 The circuit breakers and bus PTs shall be mounted on withdrawable trucks, which shall rollout horizontally from service position to isolated position. The breaker truck shall be floormounted so that it can be easily pulled out on the control room floor and the help of trolleyetc. are not to be utilized.

5.4.3 The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck inany position SERVICE, ISOLATED, TEST or removed, and all doors and covers closed. All doors, removable covers and glass windows shall be gasketed all round with synthetic rubberor neoprene gaskets.

Note: Complied for TEST & SERVICE Position. Not applicable for Isolated/disconnected Position where an isolating distance or segregation is established in the circuits (Main & Auxiliary) of the withdrawable part as per Clause no 3.129 of IEC 62271-200. The CB door need to be opened to establish isolation in the auxiliary circuit of the withdrawable part.

5.4.4 The bus VT/instrument compartments shall have degree of protection not less then IP: 52 inaccordance with IS:2147. However, remaining compartments can have a degree of protectionof IP: 42. All louvers if provided shall have very fine brass or GI mesh screen. IPH-2 degreeof protection as per IS: 3427 to all live parts shall (whether isolated or removed from panel) even when the breaker compartment door is open. Tight fitting garments/gaskets are to beprovided at all openings in relay compartment.

Note: Requirement for IP 52 is generally applicable for application which has exposure to dust and water (Protection against falling water drops when panel is tilted 15Deg on either side of the vertical). Also, the standard IS: 2147 referred in clause no 5.4.4 under this section is applicable for Low Voltage Switchgear only. It is not applicable for HV metal enclosed switchgear. Also, IP42 degree of protection is applicable for installations which has exposure to water ((Protection against falling water drops when panel is tilted 15Deg on either side of the vertical). But as per IEC 62271-200:2011 (applicable standard for indoor metal enclosed switchgear which is installed inside control rooms) the minimum degree of protection required for a metal enclosed switchgear is IP2X (i.e. prevent access to hazardous parts with fingers and protects the equipment inside the enclosure against ingress of solid foreign objects having a diameter of 12.5 mm and greater). Offered panels are tested for IP4X degree of protection (Any object probes greater than 1.0 mm Ø shall not penetrate). Therefore, we request you to accept the ingress protection as IP 4X for the enclosure

5.4.5 Circuit breaker shall be vacuum; draw out type housed in a separate cubicle of theswitchboard and shall be enclosed from all sides. A sheet steel hinged lockable door shall beat the front. It shall be possible to withdraw the circuit breaker to ‘Test’ and ‘Isolated’positions with the cubicle door closed. Door interlock shall be provided such that the door canonly be open after withdrawing the beaker to ‘Isolated’ position and the breaker cannot beracked into the ‘Service’ position unless the door is closed. A visual indication as to showwhen the breaker is in ‘Service’, ‘Test’ or ‘Isolated’ position shall be provided in front of thedoor.

5.4.6 The construction of switchgear panel shall ensure following features:

i) Enclosure shall be constructed with rolled steel sections and cold rolled steel sheets of atleast 2.0 mm thickness, Gland plates shall be 2.5 mm thick made out of hot rolled or coldrolled steel sheets and for non-magnetic material it shall be 3.0 mm.

ii) The switchgear shall be cooled by natural airflow and cooling by any other method shall not be accepted.

iii) Total height of the switchgear panels may not exceed 2600 mm. The height of switches, pushbuttons and other hand-operated devices shall not exceed 1800 mm and shall not be less than 700 mm.

iv) Safety shutters complying with IEC-60298 shall be provided to cover up the fixed highvoltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. It shall also be possible to padlock shutters individually. clearly visible warning label “Isolate elsewhere before earthing" shall be provided on the shutters of incoming and the connections, which could be energized from other end.

v) Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar/cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position.

vi) The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors, busbar and cabling compartments provided on the rear side shall have bolted compartment covers with self retaining bolts. Breaker compartment doors shall have locked facility.

vii) In the service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.

viii) Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates as per approval installation drawings.

ix) The switchboard shall have the facility of extension on both sides. Adopter panels and dummy panels required to meet the various busbar arrangement, cable/bus duct termination and layouts are included in Contractor's scope of work.

5.4.7 Plug and socket isolating Contacts for main power circuit shall be silver plated, of selfaligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material Plug and socket contacts forauxiliary circuits shall also be silver plated, sturdy and of self-aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.

5.5.0 INSTRUMENT PANELS

5.5.1 Each unit shall have its own instrument panel provided at the top & complete with smallwiring connections from relays, instrument transformers, metering instruments, indicatinginstruments, selector switches & circuit breaker control switch. All wiring shall be carried outby using stranded single annealed copper conductor insulated with poly vinyl chlorideinsulation suitable for 110 V service and in accordance with IS:732. CT/PT circuit shall usewire of not less than 2.5 mm2 cross-sectional area whereascontrol/alarm/supervision circuitshall use wire of not less than 1.5 mm2cross-sectional area.

5.5.2 All wires will be continuous from one terminal to the other and, also will have no Teejunctionenroute. The connections shall be securely made with the help of connecting lugs duly crimped on to the copper conductor. The meters and relays shall be mounted in a convenient position so as to be readily accessible for inspection or repair. The terminal board provided in the instrument panel of VCBs will be made of moulded dielectric having brass studs, washers, holding nuts & locking nuts. All holding nuts shall be secured by locking nuts. The connection studs shall project 6 mm from the lock nut surface. NO OTHER TYPE OF TERMINAL BOARD IS ACCEPTABLE. The panels shall have a degree of protection of IP-52. The leads from metering CTs shall be directly terminated at TTB & there from at the KWH meter with a provision to seal TTB and KWH meter. The said CT leads will be concealed to prevent their tempering enroute. Similarly, PT leads from secondary box of the PT to TTB & there from to energy meter including inter panel PT leads will also be concealed to prevent their tempering. The mode & extent of concealing the metering leads of CTs & PTs to prevent their tempering (by unscrupulous operating personnel) will be discussed & mutually agreed upon with the successful bidder(s). TTB used on the instrument panel should besuitable for front connections.

5.5.3 Earthing of current free metallic parts or metallic bodies of the meters/switches mounted onthe instrument panel and metal enclosed switchgear shall be done by a suitably sized copperconductor. Earth bus made of 25x8 mm bare copper flat will be extended through entirelength of 33 kV switch board with suitable provision to connect it to the sub-station earth atthe extremities. The earthing arrangement will meet with the requirements laid down in IS:3427read with its latest amendment.

5.6.0 BUS – BARS

5.6.1 All the panels shall be provided with one set of 3 phase 2500 Amps. Heat shrunk PVCSleeves insulated Main electrolytic copper bus bars for all switchboards and shall beconnected in a separate moisture and vermin proof sheet metal chamber. The bus-barsconnections& insulator supports shall be mechanically strung & rigidly supported so as towithstand the stresses generated by vibrations, variations in temperature and due to severeshort circuits.

5.6.2 The bus bars shall be Heat shrunk PVC Sleeves insulated type and supported on insulators at short intervals keeping adequate clearance as per IE rules between bus bars and earth. The bus bar chamber shall be provided with inspection covers with gaskets & bus bar shutters. Provision shall be made for future extension of bus bar & switch board.

5.7.0 CIRCUIT BREAKERS

5.7.1 The Circuit Breakers shall be with Vacuum Interrupters, with motor operated spring charging operating mechanism. The breaker manufacturer should also be a manufacturer of vacuum interrupter. The Vacuum Interrupter should be the VCB manufacturer's own make. VI manufacturing facilities should be available in India and proper documentation (i.e., ISO, factory registration, etc.) in support of that should be submitted.

5.7.2 The circuit breaker shall be trip free and shall be provided with anti-pumping device.

5.7.3 The vacuum type circuit breaker shall be draw out type & trip free. The VCBs shall besuitable for operation from 220 V DC auxiliary supply. The operating mechanism shall bemotor operated spring charged type. There shall be provision(s) for manual charging ofclosing spring and emergency hand trip. The motor used for the purpose will be suitable for240 V AC as well as for 220 V DC. The operating mechanism shall work satisfactorily at 85% - 110 % of rated supply voltage. The VCB shall have 4 normally open & 4 normally-closedauxiliary contacts over & above the ones required for various control & supervision circuits.

5.7.4 The circuit breakers shall have following ratings and characteristics:

(i) Rated voltage: 36 KV

(ii) No. of poles: 3

(iii) Rated current:

a) 2500 Amps for transformers.
b) 1600 Amps for outgoing
c) 1600 Amps for Bus Coupler
d) Bus Bar Rating: 2500Amps

(iv) Rated frequency: 50 Hz

(v) Rated breaking capacity:

(a) Symmetrical: 25 KA
(b) Asymmetrical: As per IS: 13118

(vi) Rated breaking capacity: 2.5 times the rated symmetrical breaking capacity

(vii) Short time current rating: 31.5 KA for three second

(viii) Rated voltage of operating device: 220 volts D.C

(ix) Operating mechanism: Motor operated spring charged independent spring closing mechanism

(x) Impulse withstand voltage: 170 KV (Peak)

(xi) One-minute power frequency withstand voltage: 70 KV (rms)

5.8.0 CURRENT TRANSFORMERS

5.8.1 The tenderer shall quote for cast-resin type, single-phase current transformers.
The CT ratio & cores shall be decided during detailed engineering.

5.9.0 POTENTIAL TRANSFORMERS

5.9.1 The tenderer shall quote for oil immersed or cast-resin type having the following particulars for the purpose of metering:

i)	Rated voltage ratio:	33000/110
ii)	No. of phases:	3 phases/star-star connected
iii)	Rated Burden:	50 or 100 VA for each phase
iv)	Class of accuracy:	0.2/3P/3P

5.9.2 Primary wiring of the PTs shall be protected by suitable H.R.C. fuses.

5.10.0 PROTECTIVE RELAYS

5.10.1 Protective relays for protection of transformers, 33 kV feeders and bus section shall beprovided in separate panels housed in a separate room. The protection scheme shall be as per Chapter 14 of this Volume.

5.11.0 CABLE BOXES AND CABLE GLANDS

5.11.1 Cable boxes with cable glands shall be supplied with each of the panel. It should beof adequate dimension for terminals of 33 KV, single core XLPE cables of sizes 800 sq. mm (two numbers per phase for transformer panel and one number per phase for each 33 kVoutgoing feeders.

5.11.2 The 33 KV cable boxes shall be located at the back of the switchboards and shall besuitably mounted for cables rising from cable trenches running at floor of the control room. The cable glands provided at the entrance shall have facility for earthing of metal screening ofcables.

5.11.3 All control/wire entries should be my means of suitable cable glands such glandsshould be of brass and tinned.

5.12.0 LOCAL SUPERVISION SCHEME

5.12.1 Instrument panels on each of the 33 kV VCB covered by this specification shall beprovided with the following indicating lamps/relay:

(i) Circuit breaker `open' Green

(ii) Circuit breaker `close' Red

(iii) Circuit breaker spring charged Blue

(iv) Circuit breaker `close' & `open' lamps will be wired so as to be on 240 V AC under `normal' condition. These lamps will be switched over to 220 V DC automatically in the event of failure of 240 V AC supply. Each of 33 kV (incoming) instrument panel will be equipped with a suitable relay for this purpose.

5.13.0 METERING SCHEME

5.13.1 Each of the 33 kV VCB will be provided with a suitably scaled ammeter with aselector switch facilitating measurement of phase currents as well as unbalance current. Theinstrument shall be of moving iron spring-controlled type of industrial grade `A' classificationhaving accuracy class 1.0 & shall conform to IS:1248.

5.13.2 Each of the 33 kV (incoming) VCB will be provided with a suitably scaled voltmeterwith a selector switch. The selector switch shall facilitate the measurement of phase to phase& phase to neutral voltage of all the three phases one by one. The coil of the voltmeter shallbe rated for 110 V (phase to phase). The instrument shall be of moving iron spring-controlledtype of industrial grade `A' classification with accuracy class 1.0 & shall conform to IS:1248.

5.13.3 Each of the 33 kV VCB panel (incoming & outgoing) will be equipped with a MWMeter

5.14.0 LOCAL CONTROL SCHEME

5.14.1 The instrument panel of each of the 33 kV VCB will be equipped with a circuitbreaker control handle of pistol grip type with spring return to neutral position and having bell alarm cancellation contacts. The control handle shall be so designed that after being operated to `close' a VCB the operation cannot be repeated until the control handle has been turned to `trip' position making it impossible to perform two closing operation consecutively.

5.14.2 The rating of the control handle shall be suitable for the duty imposed by the closingand opening mechanism of VCB. The moving and fixed contacts shall be of such a shape &material to ensure good contact and long life under service operating duty. All contacts shallbe readily renewable.

5.14.3 The number of contacts in the control handle will be decided by the bidder keeping inview the requirements of this specification. Two pairs of contacts shall be kept spare. Thetotal number of contacts proposed to be provided shall be stated in the bid.

5.14.4 Safety against inadvertent operation due to light touch on the control handle shall beensured.

5.15.0 REMOTE OPERATION AND SUPERVISION

5.15.1 The entire 33 kV switchgear panel shall be wired for remote operation andsupervision through BCU/RTU. Remote operation shall be either from substation HMI incontrol room or through SCADA as per Section-8 of this Volume.

5.15.2 A lockable Local/Remote switch shall be provided on the 33 kV switchgear. Atremote position the Local Control Scheme (clause 5.14.0) shall be in disabled mode.

5.16.0 PROTECTION SCHEME

9.16.1 Protective relays for protection of transformers, 33 kV feeders and bus section shallbe provided in separate panels housed in a separate room. The protection scheme for incomer (transformer) and outgoing feeders (33 kV feeders) shall be generally as per chapter 14 of this Volume. The Bus Section shall have only over current & earth fault relays.

5.16.0 PRE-COMMISSIONING CHECKS / TESTS

5.16.1 After installation of panels, power and control wiring and connect contractor shallperform commissioning checks as listed below to proper operation of switchgear/panels andcorrectness of all respects.

5.16.2 General

a) Check nameplate details according to specification.
b) Check for physical damage.
c) Check tightens of all bolts, clamps and connecting terminal.
d) Check earth connections.
e) Check cleanliness of insulators and bushings.
f) Check heaters are provided.
g) H.V. test on complete switchboard with CT & breaker / contractor lubricated inposition.
h) Check all moving parts are properly lubricated.
i) Check for alignment of bus bars with the insulators to ensure alignment and fitness ofinsulators.
j) Check for inter changeability of breakers.
k) Check continuity and IR value of space heater.
l) Check earth continuity of the complete switchgear board.
m) The VCB panel should be type tested for withstanding internal arc of 1 sec of maximumfault current for AFLR.

5.16.3 Circuit Breaker

a) Check alignment of trucks for free movement.
b) Check correct operation of shutters.
c) Check slow closing operation (if provided).

d) Check control wring for correctness of connections, continuity and IR values.
e) Manual operation of breakers completely assembled.
f) Power closing / opening operation, manually and electrically at extreme condition of control supply voltage.
g) Closing and tripping time.
h) Trip free and anti-pumping operation.
i) IR values, resistance and minimum pick up voltage of coils.
j) Simultaneous closing of all the three phases.
k) Check electrical and mechanical inter locks provided.
l) Checks on spring charging motor, correct operation of limit switches and time of charging.
m) Check vacuum (as applicable).
n) Mechanical Endurance test as per M2 class of IEC.
o) The VCB should be type tested for E2 and C2 duty.
p) All functional checks.

5.18.0 TEST

5.18.1 All routine tests shall be carried out in accordance with IS: 13118-1991(latest editionthereof). VCB and panel should be type tested within 5 years of opening of tender from any ofthe following testing laboratory: CPRI/ ERDA/ KEEMA/ KERI/ PHELA/ CESI/NABLaccredited laboratory.

Note: AEGCL will also accept the type test validity as per the latest CEA guidelines i.e., validity of the type test shall be within 10 years of opening of the tender

5.16.0 TECHNICAL PARAMETERS

Sl. No	DESCRIPTION	PARTICULARS
	BASIC PARAMETERS	
1	Type	Vacuum
2	No of Poles	3
3	Nominal system voltage	33 kV
4	Highest system voltage	36 kV
5	Rated Frequency	50 Hz
6	Rated continuous current	2500 Amp for incoming & 1250 Amp rating at an ambient for outgoing feeders
7	Symmetrical breaking	25 kA
8	Impulse withstands test voltage	170 kV (Peak)
9	One-minute power frequency withstand test Voltage	70 kV (rms)
10	Short time current	Not less than 31.5 kA for 3 sec
11	11 System neutral	Solidly earthed
	CIRCUIT BREAKERS	
1	Rated Voltage	33 kV
2	No of Poles	3
3	Rated current	(a) 2000 Amps for transformers (b) 1250 Amps for outgoing (c) 2500 Amps for bus section
4	Rated Frequency	50 Hz
5	Rated breaking capacity	a. Symmetrical 25 KA b. Asymmetrical As per IS: 13118

6	Rated breaking capacity	2.5 times the rated symmetrical breaking capacity
7	Short time current rating	25 KA for three second
8	Rated voltage of operating device	220 V DC
9	Operating mechanism	Motor operated spring charged independent spring closing mechanism
10	Impulse withstand voltage	170 KV (Peak)
11	One-minute power frequency withstand Voltage	70 KV (rms)
	CURRENT TRANSFORMERS	
	Current transformers for incoming (transformer) panel	(Refer to volume III for drawings)
1	Ratio	
2	Accuracy class	
3	Rated Burden	
4	Knee point voltage	
5	Max. Secondary Resistance	
	Current Transformers for outgoing (feeders)	
6	Ratio	
7	Accuracy class	
8	Rated Burden	
	Current transformers for Bus Section	
9	Ratio	
10	Accuracy class	
11	Rated Burden	
	POTENTIAL TRANSFORMERS	
	Rated voltage ratio	33000/110V
	No. of phases	3 phases/star-star connected
	Rated Burden	100/100/100 VA per phase
	Class of accuracy	0.2/3P/3P

SECTION - 6

TECHNICAL SPECIFICATION FOR CONTROL AND RELAY PANELS, BCU & Ethernet Switchs

6.1 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 after mounting and fully wiring up in the Control & Protection Panels.

6.2 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.

6.3 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:

6.4 TYPE TEST REPORTS.

6.4.1 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.

6.4.2 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).

6.5 TYPE OF PANEL

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

Table -1

	400kV	**220kV**	**132kV**	**33kV**
Feeder Panel	2 Nos	2 Nos	2 Nos	1 No
Bus Coupler/Tie Breaker/Sectionalizer Panel	1 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	
	2 Nos (Minimum)	2 Nos (Minimum)	2 Nos	

6.5.2 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.

6.5.3 These panels shall be of the following approximate dimensions:

i.Height: 2250mm + 15mm anti-vibration pad + 50 mm (base)
ii.Depth: 800mm to 1000 mm
iii.Width: 800 mm to 1000 mm
iv.Operating Height: 1800 mm.
Note: Simplex Panel shall be provided for all voltage classes.

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.

6.6 CONSTRUCTIONAL FEATURES:

a) 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.

b) 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.

c) 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.

6.7 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

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

   i) All circuits except instrument transformers 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.

6.9 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.

6.10 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.

6.11 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.

6.12 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.

6.13 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 25X4 mm copper. When several panels are mounted joining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provisions shall be made for extending the earth bus bar to future adjoining panels on either side.

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.

6.14 RECORDING METERS (SAMAST Compliant ABT**):**

6.14.1 General

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.

All these instruments and meters shall be flush mounted type and back connected, suitable for panel mounting.

The ABT meters shall be SAMAST compatible as per specification given in subsequent chapter.

The meters should be compatible to IEC62052-11 and IEC62053-22, IEC62053-24, IS14697, IS15959.

The manufacturer shall provide Performance Certificate from CTU/STU of successful operation of minimum 3 years as on BID Opening.

Note:

a. SAMAST Compliant ABT meters shall be supplied with the CRP as per BID/BoQ
b. Both MODBUS and IEC 61850 Protocols are acceptable provided that the Metering Servers shall have matching ports.

6.15 RELAYS:

6.15.1 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.l 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, O.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 protective relays and alarm relays shall be provided with one/two extra isolated pair of contacts wired terminals 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.

6.15.2 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 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 with non-directional overcurrent and earth fault function with high set units for power and autotransformers/ reactors.
vii) Reactor Protection.

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.

Note: AEGCL will also accept relays having 1 No. RS232/USB port on front for local relay parameterization & dual PRP compliant FO ports for connectivity to SAS. Rear RS485 port is not applicable for IEC61850 complaint relays.

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 sufficient Binary Inputs and Binary Outputs as per scheme requirement including 30% BI & BO spare.

vii) All BI/BOs shall be site configurable

viii) Shall have front minimum 3 lines LCD display with Alpha numeric keypad.

ix) Numerical relays are to be provided with built in Event / Disturbance / Fault Recorder features.

x) 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.

xi) The relays shall be site configurable (Including logic development)

xii) Configured features & set values shall be in non-volatile memory

xiii) Must have real time clock for time stamping of events/ disturbances with time synchronization inputs (GPRS etc.). Time synchronisation through SNTP compatible.

xiv) The major component cards shall be hot swappable and front or rear loading.

xv) The relays should have self-diagnostic features identifying area of fault or failure of a particular component or card. The relay should be capable of generating error report which could indicate the particular area of failure.

Note: The relays should have self-diagnostic features identifying area of fault or failure of a particular component or card. The relay should be capable of generating error report which could indicate the particular area of failure.

xvi) 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.

xvii) Relay shall have inbuilt PRP ports

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.

Note: The direction of power Flow if displayed with numeric sign is acceptable and this feature is required for all relays.

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**.**

6.16 Transmission Line Protection:

6.17 Line Differential Protection Relay (If Applicable)

Main I and Main II Line Differential Protection shall be of two different makes (i.e., from different manufacturers) or of same make with two different platforms with same specifications. Differential Relays shall be of the same make at both the end Sub Stations.

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

1. It shall be working on phase segregated Current Differential protection principle.
2. It shall have multiple slope characteristic (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults.
3. It shall measure Differential as well as restrain current continuously and shall display the same as measurement.
5. It shall communicate to remote end through IEEE C37.94 format.
6. It shall have redundant communication channels for protection communication.
7. It shall communicate analogue as well as digital signals to remote end.
8. It shall have various communication options for remote communication i.e. mono-mode / multi-mode for direct communication / communication through multiplexer.
9. It shall have Line charging current compensation feature for better sensitivity.
10. Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication. It shall have a full scheme distance protection scheme to provide independent protection in parallel with the differential scheme in case of a communication channel failure for the differential scheme. The distance protection then provide protection for the entire line including the remote end back up capability either in case of a communications failure or via use of an independent communication channel to provide a fully redundant scheme of protection (that is a second main protection scheme). Eight channels for intertrip and other binary signals are available in the communication between the IEDs.The auto-reclose for single-, two- and/or three phase reclosing includes priority circuits for multi-breaker arrangements. It co-operates with the synchronism check.
11. It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately. Time synchronization through GPS shall also be possible.
12. It shall monitor individual communication links continuously and switchover to standby link after preset time in case of failure of one link.
13. It shall supervise individual telegrams.
14. It shall detect reflected telegrams.
15. It shall detect change in communication It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm.
17. It shall also supervise maximum permissible delay time.
18. It shall generate alarm for heavily disturbed communication link. Technical Parameters
    - A. Line Differential Protection setting:
    - 1. Minimum operating current - 20 to 200% of In
    - 2. Slope (Single/dual) - 10 to 100%
    - 3. End section (Single/dual) - 20 to1000% of In
    - 4. Highset operating current - 100 to 5000% of In
    - 5. 2 nd Harmonic blocking - 5 to100 %
    - 6. Typical operating time - 25 ms
    - 7. Operating time for high set - 15 to 20 ms
    - 8. Charging current comp. – Selectable
    - B. Remote communication:
    - 9. Analogue signal transfer – Minimum 3 Nos.

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

6.18 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.

viii) 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.

ix) Shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)

x) All the zones shall have setting such that they can detect the fault online from minimum 0.3 km to 500 km.

xi) 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.

xii) 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.

xiii) 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.

xiv) 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.

xv) Shall have suitable number of potential free contacts for Carrier Aided Tripping, Auto Reclosing, CB Failure, Disturbance/Fault recorder and Data Acquisition System.

xvi) 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.

xvii) 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.

xviii) 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.

xix) 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.

xx) 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.

xxi) 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.

xxii) 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.

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

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

xxv) Shall have in built broken conductor detection by way of level detector or negative sequence measurement.

xxvi) Shall have df/dt functions.

xxvii) Shall have multistage under frequency setting options.

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

xxix) Shall have a fault locator with an accuracy of ±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.

xxx) 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.

xxxi) Have sufficient no of programmable BI, BOto cater for DR/SER carrier aided tripping auto re-closing etc. with additional 30% spare BI/BO.

xxxii) 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.

xxxiii) Shall have additional features to provide under/ over voltage protection.

xxxiv) Shall have additional features to provide under frequency protection

xxxv) 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.

xxxvi) The protective relays shall be suitable for use with capacitor voltage transformers having non electronic damping and transient response as per IEC.

xxxvii) 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.

xxxviii) Must have a current reversal guard feature.

xxxix) 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

xl) Have feature of load encroachment blinder to safeguard the protection trip during heavy line loading condition.

6.19 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 impedancetype.

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 in case of 400kV class or 6 analogue channels for lower voltage transformers and voltage in one 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 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.

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 low impedence REF element. Also, the Bidder shall have to supply standalone High Impedence REF Relays separately for the Transformers. 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 1to 10 seconds continuously.

5) Over Current and Earth fault protection:

i) The relay shall have three stages of definite time over current protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current.
ii) In addition, the relay shall have three stages of Inverse time over current protection operating based on one measuring system each for the three phase currents, the negative sequence current and the residual current.
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)

6.20 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 blocked scheme on Reverse Power Flow.
(ix) Include LED indicators.

6.21 Reactor Protection

6.21.1 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 impedancetype.

(viii). Be stable for all external faults.

6.21.2 **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.

6.21.3 **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.

6.22 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 degrees
- 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.

6.23 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 and transfer bus (as applicable) for 220KV 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 type only and it must accommodate minimum 10 future bays 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.

6.24 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

6.25 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.

6.26 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.

6.27 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

6.28 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.

6.29 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**.**

6.30 BAY CONTROL UNIT (BCU)

- The BCU must be type tested at KEMA/Internationally or nationally acredited 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 back up directional & non-directional back-up protection features in addition to 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.
  Note: AEGCL will also accept redundant supply source with auto-changeover outside the Relay /IED/BCU. In case of a power failure in one source, Relays/BCU shall get supply from other source through an auto change-over scheme. Any supply failure shall also 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 information
  i) the bay names
  ii) the date and time
  iii) the Local / Remote/Maintenance Bay mode
  iv) the auto-recloser function status (on / off),
  v) the synchro check 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.

6.31 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.

6.31.1.1 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 decide during detailed engineering.

6.31.1.2 The managed Ethernet switch shall have minimum 20% port redundancy (Both Fibre & Copper ports).

6.31.2 Ethernet Switches shall have redundant power card.

6.31.3 Port monitoring software for Ethernet Switches are to be provided.

6.31.4 The make of the Ethernet switches shall be Ruggedcom/Hirschman/ABB.

6.32 FAULT RECORDER:

6.32.1 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.

6.32.2 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.

6.32.3 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.

6.32.4 Fault recorder shall have at least 8 analogue and 16 digital channels for each feeder.

6.32.5 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.

6.32.6 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.

6.32.7 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.

6.32.8 The evaluation unit hardware shall be as described in clause no. 4.0 of section sub-station automation.

6.32.9 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.

6.32.10 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 signals 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)

6.32.11 The Evaluation unit shall be connected to the printer to obtain the graphic form of disturbances whenever desired by the operator.

6.32.12 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.

6.32.13 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 fails 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.

6.32.14 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.

6.32.15 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.

6.33 DISTANCE TO FAULT LOCATOR:

6.33.1 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.

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

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

6.33.4 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

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

6.34 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 Clause14.30 and 14.31 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.

- **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 Clause14.30 and 14.31 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.

- **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. 30 and 14.31.

  b) Backup Protection:

The backup protection shall be provided with directional single/ multi pole relays as specified in Clause 14.33. 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 14.33. 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 14.32 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 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 non-directional relays as specified in Clause 14.32/ 14.33. 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 14.36 of the BID for 400kV and 220kV Voltage Level.

- **Reactor Protection Panel:**

The Reactor Protection shall be provided as detailed in Clause 14.34 of the BID.

6.35 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.

6.36 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)

6.37 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.

6.38 TECHNICAL DATA SHEET FOR THE RELAY AND CONTROL PANELS

- Features to be provided in various Relay and Control panels are indicated below. Description below is 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.

<u>400kV and 220kV Feeder Panels:</u>

SL NO	ITEM	RATINGS AND PARTICULARS	
		400KV Panelwith 1 1/2 Breaker Scheme	220KV Panel with Main I & Main II
I	II	III	IV
A	**LINE PANELS**		
1	**Protection and relays:**		
	(a)DistanceProtectionSchemeI	1 No.	1 No.
	(b)DistanceProtectionSchemeII	1 no	1 no
	(c) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(d)TripCircuitSupervisionRelayforpreandpost-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)DCSupplyhealthymonitoringschemefortwo 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-CVTSelectionSchemewithPT1-PT2–CVT selectionrelay	1 Set. Complete Bus PT1-Bus PT2-CVT	1 Set. Complete Bus PT1-Bus PT2-CVT

		Selection Scheme	Selection 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	-	-
	(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)

220KV Feeder Panels (Line Differential)

Sl No	ITEM	Ratings and particulars
A	**Line Panels**	
1	**Protection and relays:**	
	(a) Line differential protection scheme I	1 No
	(b) Line differential Protection scheme II	1 No
	(c) Distance Protection Scheme-I	As in-built back up function of Line differential relay
	(d) Distance Protection Scheme-II	As in-built back up function of Line differential relay
	(e) Back up directional over current and earth fault scheme	As in-built back up function of Line differential relay
	(f) LBB Protection Scheme	Can be function of BCU/IEDs
	(g) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coils per pole or phase)
	(h) DC Supply healthy monitoring scheme for two separate DC source	2 No.
	(i) DC Changeover Relay	2 No
	(j) AC supply healthy monitoring scheme	1 No.
	(k) 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)
	(l) PT-CVT selection Scheme with PT1-PT2-CVT selection relay	1 Set. Complete Bus PT1-Bus PT2-CVT Selection Scheme

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

132kV and 33kV feeder Panels:

SL NO	ITEM	RATINGS AND PARTICULARS	
		132 kV Panel with Main &Transfer BusScheme	**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 functionof BCU/IEDs
	(e)TripCircuitSupervisionRelayforpre and post-closing	Supervision for 2 trip coils	Supervision for 2 trip coils
	(f) DC Supply healthy monitoringscheme, for two DC source	2 No.	2 No.
	(f 1) DC Changeover	2 Nos	2 Nos
	(g) AC Supply healthy monitoringscheme	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 functionofBCU)	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	

	(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 TransformerPanel
		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	1 No (inherent low imp REF) + 1 No standalone High Imp REF Relay	1 No (inherent low imp REF) + 1 No standalone High Imp REF Relay	1 No (inherent low imp REF) + 1 No standalone High Imp REF Relay	1 No (inherent low imp REF)+ 1 No standalone High Imp REF Relay
	(c) Back up non-directional over current schemeforHVside	Could be feature of relay	Could be feature of relay	Could be feature of relay	Could be feature of relay
	(d) Back up non-directional over current andearthfaultschemeforMV/LVSide	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 functionofBCU/IEDs	Can be function of BCU/IEDs	Can be function ofBCU/IEDs	Can be function of BCU/IEDs
	(f) Over Fluxing Protection scheme	2 Set	1 Set	1 Set	1 Set-
	(g) Overload protection scheme	1 No	1 Set	1 Set	1 Set
	(g.1) Tertiary Side O/C and Open Delta Voltage Protection	1 set	-	-	-
	(h)TripCircuitSupervisionRelayScheme for ascertaining pre- and post-closing healthiness	Supervision for4 trip coils (2tripcoilsper breakeroneachside)	Supervisionfor4 trips coils (2tripcoilsper breakeroneachside)	Supervisionfor4 trips coils (2tripcoilsper breakeroneachside)	Supervisionfor4trips coils (2tripcoilsper breakeroneachside)
	(i)DCSupplyhealthymonitoringscheme	3 No.	3 No.	2 No.	2 No.
	(i1) DC Changeover Relay	2 No.	2 No.	2 No.	2 No.
	(j)ACSupplyhealthymonitoringscheme	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	1No. Complete Bus PT Selection Scheme (Canbefuncti onof BCU)	1No. Complete Bus PT Selection Scheme (Canbefunctionof BCU)	1No. Complete Bus PTselection scheme (Can be function of BCU)	1No. Complete Bus PTselection scheme (Can be function of BCU)
	(m1) PT Selection Relay	3 Nos for HV/ 2 Nos for LV	2 Nos for HV/ 1 No for LV	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
2	**Meters**				
	(a) ABT tri-vector Meter (SAMAST Compliant) With TTB	2 No. (on 400kV and 220 kV side)	2No. (on 220 kV and 132 kV side)	2No. (on 220 kV and 33kV side)	2 Nos. (132 kV & 33 kV side)
3	**Controls / interlocks / Status indication/ Annunciation**				
	Bay Control Unit (IED), one on 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)

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 IIScheme	132 kV Panel with Main 1 &TransferBus 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)DCSupplyhealthymonitoringscheme	2 No.	2 No.
	(e)DC Changeover Relay	2 No.	2 No.
	(f)ACSupplyhealthymonitoringscheme	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 functionof 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 ofBCU/ SAS)	1 No. (Function ofBCU/ 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 Supplyhealthymonitoringscheme	2 No.
	(f) DC Changeover Relay	2 No

	(f)ACSupplyhealthymonitoringscheme	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.

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.

<u>NOTE:</u> 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-7
SUB STATION AUTOMATION SYSTEM

7.1 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	Class2: 1g from 2 to 150Hz
		Class 2: Acceleration: 1g from 10 (1) to 150Hz
Vibration Response – Not Powered On	IEC 60255-21-1	Class 2: 2g from 2 to 500Hz
		Class 2: Acceleration: 2g from 10 (1) to 500Hz
Vibration Endurance – Not Powered On	IEC 80068-2-6	Class 2: 1g from 10 to 150Hz
		Classe 2: Acceleration: 1g from 10 (1) to 500Hz
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	TestBd: +70°C/96hPowered 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<150ms/I<10A T > 500 ms / I < 1,2 In
Supply variation	IEC 60255-6	Vn +/- 20% Vn+30% & Vn-25% for information
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		2Vn 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)

		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 µF
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 exclude data for 5 (five) numbers future provision bays. 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 exclude data for 3 (three) numbers future provision bays. 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.
-

7.2. SYSTEM DESIGN

General System Design

- The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions.
- 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.**

7.3. 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.

7.4. 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 incase 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.
-

7.5. 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 disconnector, earth switches and instrument transformer) Level Functions
b). System Level Functions

7.6. 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.

7.7. 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/Os 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

V**oltage 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.

7.8. 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.

7.9. 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.**

7.10. 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 Disconnector

- 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.

7.11. 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.

7.12. 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.

7.13. 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.

7.14. EXTENDIBILITY IN FUTURE
Offered substation automation system shall be suitable for extension in future for **additional eight bays**. 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.

7.15. 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.

7.16. 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.

7.17. 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.

7.18. 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.

7.19. 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.**

7.20. 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.

7.21. 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.

7.22. 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.

7.23. 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 hand-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 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.

7.24. 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.

7.25. 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 = Σ 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.

7.26. 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.

7.27. 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 MANDATARY 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)

7.28. 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.

7.29. 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.

7.30. 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.

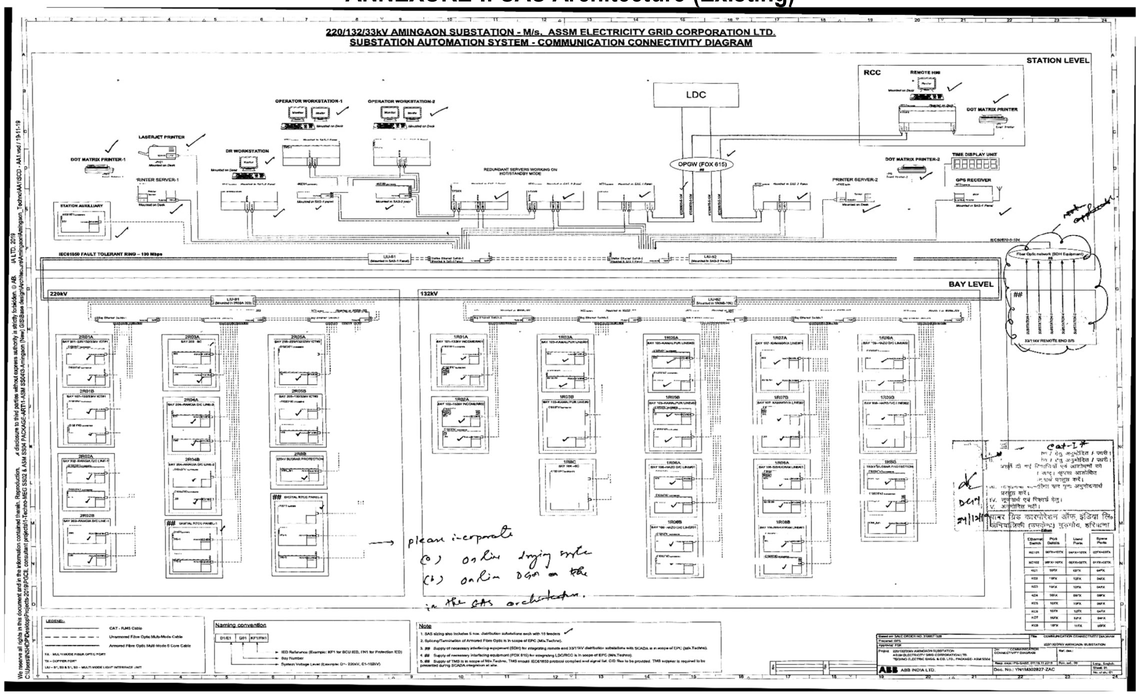
Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole during the pre-commissioning and commissioning periods. The test 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. Manufacturer has the responsibility to take care of replacement of minor items if required to restore the system, however responsibility of replacing major items if required is the Employer's responsibility. 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 (Existing)



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, Δφ; 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**

o For line R, Y, B phase line currents & R-N, Y-N, B-N phase voltages

o For transformers □□R, Y, B phase line currents for HV & LV

- OTI & WTI
- Tap position

o For bus coupler R, Y, B phase line currents

o 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

o 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

o 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

o 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 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	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
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	O/V_STG1_OPTD	O/V_ST1	Y	

	OPERATED				
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	
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	
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_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

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

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	OVERVOLATGE STAGE 1 START	
2	SPI	OVERVOLATGE STAGE 1 GEN TRIP	Y
3	SPI	OVERVOLATGE 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)	DIFFRENTIAL IED UNHEALTHY	Y
10	SPI	DIFFERENTIAL RELAY GENERAL TRIP	Y
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
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 TOBEGENERATED**
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)	DIFFRENTIAL 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
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**
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)	DIFFRENTIAL 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)	DIFFRENTIAL 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**	

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	M1 IED UNHEALTHY	Y

	(SON)		
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		
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 TRANSFORMERS CSWI7 MAY BE USED FOR 89 T BUT FOR SINGLE PHASE TRANSFORMERS 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 TRANSFORMERS CSWI7 MAY BE USED FOR 89 TE BUT FOR SINGLE PHASE TRANSFORMERS SAME HAS BEEN SEPARATELY MENTIONED
32	CMD	BAY_89 CE/LE/TE_ISO COMMAND		
33	SPI	BAY_89 CE/LE/TE_ISO OPEN PERMITTED OR ENABLED		
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	
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 from110V 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 Volatge
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-8

TECHNICAL SPECIFICATION OF 33KV, 132KV & ABOVE XLPE CABLE AND TERMINATION

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

8.2 STANDARD & CODES

(ii) ***The works covered by the specification shall be designed, engineered, manufactured, tested and commissioned in accordance with the Standards as specified in the table below.***

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

IS 7098 : Part 3 : 1993	Cross-linked polyethylene insulated thermoplastic sheathed cables: For working voltage from 66KV up to and including 220KV.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 1255 : 1983	Code of practice for installation and maintenance of power cables upto and including 33KV rating.
IS 3975 : 1999	Mild steel wires, formed wires and tapes for armouring of cables.
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 6380 : 1984	Elastomeric insulation and sheath of electric cables.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords.
IS10418 : 1982	Drums for electric cables
IS 5 : 1994	Colours for ready mixed paints and enamels.
IS 617 : 1994	Aluminum and aluminium alloy ingots and castings for general engineering purposes (Superseded IS 20: 1977)
IS 3043 : 1987	Code of practice for earthing.
IS 5578 : 1984	Guide for marking of insulated conductors.
IS 11353 : 1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
IS 5216 : Part I : 1982	Recommendations on Safety Procedures and Practices in Electrical Work.
IS 2071 : 1993	High voltage test techniques.
IEC-60540	Power cables with extruded insulation and their accessories and cords
EC 60060 : 1989	High Voltage Test Techniques
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1KV up to 30KV
IEC-60754 : 1991	Tests on gases evolved during combustion of electric cables
IEC-60183 : 1990	Guide to the Selection of High Voltage Cables.
IEC-60230 : 1996	Impulse tests on cables and their accessories.
IEC-60840 / IEC- 62067	Testing

IEC-60287 : 1995	Calculation of the continuous current rating of cables (100%load factor).
IEC-60304 : 1982	Standard colours for insulation for low-frequency cable and wires
IEC-60331 : 1970	Fire resisting characteristics of Electric cables.
IEC-60332 : 1992	Tests on electric cables under fire conditions.
BS-5468	Cross-linked polyethylene insulation of electric cables
IEC-60228 : 1978	Conductors of insulated cables
IEC-60332 : 1993	Test on electric cables under fire conditions
IEC-60066	Environmental Test
IEC-60117	Graphical Symbols
IEC-60270 : 2000	Partial Discharge Measurements
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)

8.3 COMPLIANCE TO SPECIFICATION & DEVIATION:

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

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

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

8.4 CONSTRUCTION

1. **For 66KV and above:**The cable shall be of applicable EHV grade as per requirement according to price schedule, single core, unarmored, stranded compacted circular Copper conductor in case of cross section less than or equals to 800 sq.mm or segmental compacted circular (Miliken) Copper conductor in case of cross section over 800 sq.mm, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, crosslinked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non woven tape with water swellable absorbent over insulation screen, followed by radial sealing of corrugated & seamless or seam welded aluminum with asphalt coating & overall HDPE sheathed (conforming to IEC 60840) & graphite coated and conforming to the technical particulars of specification.

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

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

2. The construction of cable shall generally conform to the description mentioned above. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable. The bidder shall enclose with the bid, drawing showing cross section of the cable.
3. The cable shall be suitable for laying underground with uncontrolled back fill and chances of flooding by water and suitably designed by the addition of chemicals in the outer sheath to be protected against rodent and termite attack.
4. The cables shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
5. Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of the cable.
6. 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.
7. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2mm.
8. **IS 7098 part III shall be followed for cable construction.**

8.5 COMPOSITIONS OF CABLES

CONDUCTOR

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

CONDUCTOR SCREEN

The conductor screen shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE.

INSULATION

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

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

INSULATION SCREEN

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

MOISTURE BARRIER

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

METALLIC SCREEN:

The metallic screen shall be of Lead Alloy 'E" as per IS 7098 Part III sheet with asphalt coating. The metallic screen shall be designed to meet the requirement of the system **short circuit rating of 31.5KA for 1 sec (for 33KV and 66KV), 40KA for 1 Sec (for 132KV) and 50KA for 1 sec (for 220KV).** Copper wire screening may be used if required to meet the above ratings.

ARMOURING (FOR 33KV CABLE)

a) The armoring shall be of non-magnetic material.
b) Armoring shall be applied over the insulation or protective barrier or non-metallic part of insulation screening, in case of single core cables or inner sheath in case of screened and armoured single core cables.
c) The armour wires/strips shall be applied as closely as practicable the direction of lay of the armour shall be left hand. For double wires/strips armoured cables, this requirement shall apply to the inner layer of wires/strips. The outer layer shall, except in special cases, be applied in the reverse direction to the inner layer, and there shall be a separator of suitable non-hygroscopic material; such as plastic tape, bituminized cotton tape, bituminized hessian tape, rubber tape, proofed tape between the inner and outer layers of armour wires strips.
d) A binder tape may be applied on the armour.
e) The joints in armour wires of strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire/strip shall be at least 300 mm from the nearest joint in any other armour wire/strip in the completed cable, Number of joint in a single wire to be limited.

OUTER SHEATH

The outer sheath shall consist of Extruded black HDPE (TypeST7) grade. The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

8.6 RATING

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

8.7 CABLE DRUMS

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

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

Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with hermetically sealed by means of water blocking compound followed by heat shrinkable caps totally coated inside with mastic so as to prevent to cable for moisture penetration during transit, storage and laying.

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

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

- **(a) Name of Customer i.e. AEGCL**
- **(b) Conductor size, type of insulation and voltage grade.**
- **(c) Manufacturer's name.**
- **(d) Year of manufacturing**

8.8 TESTS

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

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

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

b. Chemical composition test for verifying lead sheath composition.

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

TESTS AFTER INSTALLATION

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

8.9 TRENCHING

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

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

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

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

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

The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

The bottom of the excavated trench should be levelled flat and from any object which would damage the cable. Any gradient encountered shall be gradual.

8.10 PAYING OUT

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

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

8.11 LAYING OF CABLES

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

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

b) Clearances from relevant authorities for lying of cables.

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

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

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

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

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

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

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

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

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

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

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

8.12 LAYING OVER PRE-CONSTRUCTED TRENCH

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

8.13 CLAMPS

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

Self-supported Aluminium Spring load clamp shall be provided for Cable termination structure at every 1 metre of cable run. The contractor shall submit the drawings of spring load clamp for employer's approval.

8.14 CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surface, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to IS1255- 1983 or its equivalent.

DAMAGE TO PROPERTY

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damages caused shall be immediately repaired and brought to the notice of the concerned and to the Employer.

- The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.
- At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes of adequate strength using HDD technology.

8.15 CABLE ROUTE MARKERS / CABLE JOINT MARKERS

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

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

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

8.16 DEPTH OF LAYING OF CABLES

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

8.17 SAND BEDDING

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

8.18 THERMAL BACK FILL

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

8.19 IMMEDIATE ENVELOPE TO CABLE

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

8.20 BACKFILLING

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

8.21 WARNING TAPE

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

CAUTION: AEGCL ….. KV CABLES.

8.22 PREVENTION OF DAMAGE DUE TO SHARP EDGES

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

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

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges.

The cables shall never be bent, beyond the specified bending radius.

8.23ROAD, RAIL & CANAL CROSSINGS

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

8.24 TRENCHLESS DIGGING

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

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

8.25 FOOTPATH CUTTING

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

8.26 REINSTATEMENT

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the Employer. The protective covers shall then be provided the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50mm and not more than 100mm in the centre and tape ring towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required the temporary reinstatement should be done.

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

8.27 MANHOLES

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

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

The contractor shall submit design and drawing of Jointing Bay including manholes in the buried cable trench portion for withstanding a live load of 20 tons vehicle plus 30% for impact from moving vehicle. The Contractor shall propose a suitable procedure for testing the manhole for approval by the Employer.

Manholes type approved by the Employer only shall be acceptable. The manhole shall include sufficient number of suitable entries.
All works shall be carried out under supervision of the engineer in charge of his representative.

8.28 TOOLS AND PLANTS

The successful bidder shall have all necessary tools, plant and equipment to carry out the survey and cable installation work.
The bidders are instructed to give all the details of equipment at their disposal to carryout the work successfully and speedily.

8.29 BENDING RADIUS:

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

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

8.30 CABLE END TERMINATIONS & JOINTING

The cable jointing accessories shall include the end terminating kits, straight through joints and also any special tools and tackles required for making these joints.
The straight through joints shall be Pre-molded Heat Shink type complete with all accessories. The joint shall preferably be built up as per the construction of the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical climatic conditions.
The outdoor end termination up to 245 KV XLPE Cable shall be Anti-fog, Pre-molded type Silicon Rubber stress cone. Torque controlled mechanical shear head bolted connector with polymeric composite housing (resin cast body with silicon shed housing), dry type self-supporting with Plug-in / Plug-out facilities. The termination base plate and the cable's metallic sheath shall be electrically insulated from the self supporting structure by means of stand-off epoxy insulators designed to withstand both mechanical and electrical stresses in services. The Polymeric insulator in grey colour shall be used. In addition, upon, arcing horn and shield ring shall have to be supplied as required for 245 & 420 KV XLPE cables.
The outdoor end termination for 400kV shall be based on the Silicon / EPR-based stress relief cone with the epoxy housing and the oil-impregnated cylindrical capacitor cone (so called condenser cone type) to secure the uniform longitudinal voltage distribution all along the termination. Pre-molded type Silicon Rubber sleeve outdoor end termination for 400kV may be offered by the manufacturer if the same is available.
The outdoor terminals should be suitable for heavily polluted atmospheric conditions with total creepage distance of 31 mm/ kV and protected creepage distance of not more than 50% of the total creepage distance.
The cable end terminals for terminating the cables shall be fully compatible with the cables to be supplied.
The Indoor Termination at GIS SF6 Housing shall be based on the Silicon Rubber based stress relief cone and the epoxy resin housing. There shall be mechanical devices to maintain the interface pressure. Stress relief cone and mechanical devices shall be designed to fit with controlled interference over the cable insulation and shall follow the cable's diameter variations still guaranteeing under any service condition a sufficient positive pressure to control the electric field concentration. There shall be epoxy insulating plate to isolate between cable sheath and GIS chamber. The SVLs (Sheath Voltage Limiter) shall be installed to protect epoxy insulating plate from switching impulse. Plug-in type leading conductors shall be supplied though at the time of detailed engineering confirmation shall be given for selection of plug-in type. Design and

scope of delivery shall be fully complying with IEC-60859, IEC-62271-209 and possibly adjusted to various needs of project. The main insulation components shall be fully examined and tested in the factory.

For jointing and terminations, one qualified Engineer and required trained EHV jointers with supporting staff should be deputed. The engineer and EHV jointers shall possess valid certificate from the manufacturer of the Accessories, for erection.

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

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

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

WORKING PROCEDURE FOR TERMINATION

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

(ii) The rise of the cable immediately from the ground shall be enclosed in PVC/ PE pipe of suitable diameter to protect against direct exposure to the sun.

(iii) The cable shall be properly fastened using non-metallic clamps.

(iv) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.

(v) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

(vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fiber shroud.

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

WORKING PROCEDURE FOR JOINTING

(i) The cable jointing personnel and his crew shall have good experience in the type of jointing and terminations that are used. The jointing works shall commence as soon as two or three lengths of cable have been laid. All care should be taken to protect the factory-plumbed caps/ seals on the cable ends and the cable end shall be sealed whenever the end is exposed for tests.

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

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

(iv) The joint bay should be sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed. **3 ph link box for cross bonding to be placed inside the bay with provision for easy access for maintenance purpose.**

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

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

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

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

(ix) SUMPHOLES

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

(x) TENTS/COVERS

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

(xi) PRECAUTIONS BEFORE MAKING A JOINT

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/ inclement weather conditions which might become uncontrollable.

If the cable end seals of cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

(xii) MEASUREMENT OF INSULATION RESISTANCE

Before joining, the insulation resistance of both sections of cables shall be checked.

(xiii) The identification of each phase shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

8.31 BONDING OF SCREEN/ SHEATH

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

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

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

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

8.32 CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

If the metallic radial water barrier is insulated from the metallic wire screen a connection suitable to carry the currents occurring during operation must be installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

8.33 STATUATORY APPROVAL OF WORKS

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

Electrical Inspector. Necessary coordination and liaison work in this respect shall be the responsibility of the contractor.

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

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

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

8.34 INSPECTION, TESTING AND COMMISSIONING

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

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

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

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

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

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

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

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

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

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

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

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

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

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

a) EHV cable & optical fiber cables.

b) Jointing & termination kits for above items

8.35 ENGINEERING DATA AND DRAWINGS

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

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

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

8.36 INSTRUCTION MANUAL

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

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

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

8.37 QUALITY ASSURANCE PROGRAMME

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

b. Quality Assurance Documents

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

(i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
(ii) Welder and welding operator qualification certificates.
(iii) Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.
(iv) Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
(v) Stress relief time temperature charts/ oil impregnation time temperature charts.
(vi) Factory test results for testing required as per applicable codes/ mutually agreed quality plan/ standards referred in the technical specification.
(vii) The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

8.38 EQUIPMENTS & STRUCTURES FOR CABLE TERMINATION

1. The terminating structure being provided should be designed as per the requirement of the cable end sealing, porcelain bushing etc. The mounting structure shall be fixed on the cement concrete foundation, the design and drawings of which shall be submitted to Employer for review and acceptance during the course of detailed engineering.

   After fixing the end termination, the cable shall be fixed to the support, with non- magnetic material clamps to the required height securely. The mounting structure includes the supports for cable end boxes, link boxes and any other structure required for the intent of the contract. All steel sections used shall be free from all imperfections, millscales, slag intrusions, laminations, fillings, rust etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Employer.
2. Suitable fencing should be provided at the cable terminating yard at cable conductor junction point. The fencing will consist of galvanized steel XPM structure over a brick wall of 2(two) feet meeting electrical requirement (IE). A suitable entry point (gate) has to be provided.
3. Outdoor type 120KV lightning arresters for each cable of both the circuits are to be provided at cable-conductor junction point. The technical specification of lightning arresters is given separately **in** this volume.
4. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Employer. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification andthecatalogues or the bid, if not clearly brought out in the specific requisite schedule will not be considered as

valid deviation.

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

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

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

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

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

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

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

Successful bidder on receipt of structural drawing from department shall submit within 15 days, a detailed raw material procurement plan indicating MS sectionwise producers name to the Engineer for approval. On according approval in this aspect, work for fabrication protos shall be taken up in hands.

Entire fabrication job of MS structural shall not be entrusted to more than two sub- vendors. Further, a list of bonafide fabricators, not exceeding 6 (six) shall be furnished to the Engineer for according approval within 15(fifteen) days from the date of handing over of drawings.

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

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

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

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

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

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

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

Washers shall be made of steel conforming to IS:226, IS:961 as may be applicable under the provisions of the contract and shall be electrogalvanized.

7 FASTNERS & CONNECTIONS:

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

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

c) STEP BOLTS: Step bolts shall be of 16mm diameter and shall have round or hexagonal head. Each step bolt shall be provided with two hexagonal nuts. The minimum bolt length and length of unthreaded portion shall be 180 and 125mm respectively. Step bolts shall not be used as connection bolts. The step bolts shall be spaced alternately on the inner gaugelineoneachfaceoftheangleabout40cmcenters.Theyshallbefurnished for one leg of each steel structure column from its base elevation.

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

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

8.39 MATERIAL/ WORKMANSHIP

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

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

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

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

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/ foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification.

Provision for Exposure to Hot and Humid climate: Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew.

8.40 PACKAGING & PROTECTION

a. All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Bidder shall also submit packing details/ associated drawing for any equipment/ material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railway etc. shall be to the account of the Bidder. Employer takes no responsibility of the availability of the wagons.
b. All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All

exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damaged. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

8.41 FINISING OF METAL SURFACES

a. All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized to service condition. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized accordingtoIS:2629.

b. HOT DIP GALVANISHING

The minimum weight of the zinc coating shall be 610gm/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface, which shall be embedded in concrete the zinc coating shall be 610gm/sqm minimum.

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

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

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

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

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

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

c. PAINTING

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

The surfaces, which are to be finished painted after installation or require corrosion protection until installation shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

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

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

The exterior color of the paint shall be as per shade no: 697 of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Each coat of primer and finishing paint shall be slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

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

8.42HANDLING, STORING AND INSTALLATION

a. In accordance with the specific installation instructions as shown on manufacturer’s drawings or as directed by the Employer or his representative, the Bidder shall unload, store, erect, install, wire, test and place in to commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energization at rated voltage.
b. Bidder may engage manufacturer’s Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Bidder shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer’s supervisory Engineer(s) and shall extend full cooperation to them.
c. In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer’s drawings or instruction, necessary clarifications shall be obtained from the Employer. Bidder shall be held responsible for any damage to the equipment consequent to not following manufacturer’s drawings / instructions correctly. Where material/ equipment is unloaded by Employer before the Bidder arrives at site or even when he is at site. Employer by right can hand over the same to Bidder and there upon it will be the responsibility of Bidder to store the material in an orderly and proper manner.
d. The Bidder shall be responsible for making suitable indoor storage facilities to store all equipment, which require indoor storage.
e. The words ‘erection’ and ‘installation’ used in the specification are synonymous.
f. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
g. The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Bidder shall immediately proceed to correct the discrepancy at his risks.

8.43 QUALITY CONTROL:

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

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

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

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

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

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

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

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

vi) Galvanizing: Tests in accordance with IS:2633 – Method of testing uniformity of coating on zinc coated articles and IS:2629 Recommended practice for hot - dip galvanizing of iron and steel. Raw zinc & samples collected from bath shall be tested at third party laboratory as per direction of the Engineer.

The contractor shall submit a detailed material inspection plan on the basis of various IS codes & standard practices in respect of structural fabrication, galvanization, bolts, nuts, anchor bolts etc. much prior to commencement of the job.

8.44 FABRICATION WORKMANSHIP:

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

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

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

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

All members shall consist of rolled steel sections.

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

All members shall be cut to jig and all hole shall be punched and drilled to jig. All parts shall be carefully cut and holes accurately located after the members are assembled and tightly clamped or bolted together. Drifting or rimming of holes shall not be allowed. Holes for bolts shall not be formed by gas cutting process.

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

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

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

All bolts shall be galvanized including the threaded portion except the foundation bolts for which galvanizing work shall be done for a length of 100mm (min) to 175mm (max) measured from the tip of the treaded portion. The threads of all bolts shall be cleared of smelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the Engineer. All nuts shall be galvanized with the exception of the threads which shall be oiled. In case of foundation bolts the same shall be galvanized excepting the length of embedment.

When in position all bolts shall project through the corresponding nuts but not exceeding 10 mm. The nuts of all bolts attaching insulator sets and earth conductor clamps to the structure shall be carefully positioned as directed by the Engineer.

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

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

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

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

8.45 CLEANING & GALVANIZING: CLEANING:

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

GALVANIZING:

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

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

Galvanizing for fasteners shall meet the requirements of IS:1367. The spring washers shall be electrogalvanized as per IS:1573.

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

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

Mass of Zinc Coating:

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

MASS OF ZINC COATING

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

STRAIGHTENING AFTER GALVANIZING:

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

REPAIR OF GALVANIZING:

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

SHOP ASSEMBLY:

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

SHOP TEST:

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

a) General Inspection
b) Material test.
c) Assembly test.
d) Galvanizing test.

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

8.46 FOUNDATION WORKS:

GENERAL REQUIREMENT:

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

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

8..47 DESIGN OF FOUNDATIONS:

8.48 STEEL STRUCTURE FOUNDATIONS:

The foundations shall be designed such that the upper structure shall be securely supported. Any unequal displacement that may cause harmful effect to the upper structures shall not be allowed. The safety factors for strength and stability of the foundations shall be as per relevant code.
The overload factor shall be taken as 1.1 for designing foundations of all gantry and equipment. The loads, shear and moment values shall be multiplied with this overload factor, so as to obtain the design values.

8.49 ELECTRO-MECHANICAL EQUIPMENT FOUNDATIONS:

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

20.46.1 Minimum base slab thickness of footings : 200mm
20.46.2 Minimum bar dia for foundation : 10 mmTOR
20.46.3 Minimum bar dia for columns :12mmTORwith binder spacing limited to 190 mmc/c

iv. Clear cover to: Main bars in base slab : 50 mm
Main bars in columns : 40 mm
Main bars of beams : 40 mm

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

8.50 OTHER DETAILS

A) DETAIL DESIGN CALCULATION:

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

i) Detailed calculation of loads acting on foundation under different loading conditions.
ii) Calculated safety factor for each type of stability and other conditions.
iii) Maximum stresses in concrete and in steel reinforcement at any critical section.

B) LINE AND GRADE:

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

C) DETAIL DRAWINGS:

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

i) Detail dimensions of foundation.

ii) Details of setting dimensions of foundation.

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

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

8.51 WEIGHT OF SUB-STATION STRUCTURES:

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

8.52 Technical Specification for Underground Fibre Optic Cable

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

8.52.1 General

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

8.52.2 Applicable Standards

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

i). ITU-T Recommendations G.652

ii). Electronic Industries Association, EIA/TIA 455-78A, 455-3A/33/41/25A / 81A / 82B, 455-62A, 455-164A/167A/174, 455-168A/169A/170/175A, 455-176, 455-59, EIA/TIA 598, EIA 455- 104.

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

iv) Bellcore GR-20

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

vi) ASTM:A167-92,ASTM:751-92b,ASTM:A751-92,ASTM:A370-82,ASTM:D2581-91,ASTM:D2287-81, ASTM:D 638 for FRP, ASTM :D 217,556, 93-IP-34 for Jelly, ASTM:D
570,211 for PBTP, ASTM:D1505for Poly Carbonate, ASTM:D1633,150 for HDPE.

8.52.3 Fibre Type(s) and Counts

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

DWSM Optical Fibre Characteristics (Table-1)

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 µm (± 0.6 µm)
Cladding Diameter:	125.0 µm +/- 1 µm
Mode Field concentricity error	≤0.6%
Cladding non-circulatory	≤ 1%
Cable Cut-off Wavelength λ_{cc}	≤ 1260 nm
1550 nm loss performance	As per G .652
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum: **Zero Dispersion Wavelength:** **Zero Dispersion Slope:**	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339 nm 5.3 ps/(nm x km) 1271-1360 nm 1300 to 1324 nm 0.092 ps/(nm^{2}xkm) maximum
Polarization mode dispersion Coefficient	≤0.2 ps/km$^{1/2}$
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60^{0}C - + 85^{0}C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤0.05 dB @ 1550 nm (30±1 mm radius Mandrel) 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

8.52.4 General Cable Construction

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

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

Colour Coding & Fibre Identification

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

Strength Members

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

Filling Compound

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

The Sheath / Inner jacket

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

Armouring of cable

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

The Outer Jacket

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

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

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

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

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

8.52.6 Cable drums, Marking, Packaging and Transport

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

i) Drum number
ii) Consignee's name and address
ii) Contractor's name and address
iv) Type of cable
v) Number of fibres
vi) Type of fibres
vii) Year of manufacturing, month & batch no
viii) Name of manufacturer
ix) Total cable length
x) Inner end marking and Outer end marking

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

8.52.7 Optical fibre cable marking

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

i) Type of Cable
ii) Running meter length
iii) Number of fibres
iv) Type of fibre
v) Laser symbol & caution notice
vi) Year of manufacture and batch no.
vii) Manufacturer's name
viii) Owner's Name

8.52.8 Operating Instructions

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

8.52.9 Test and Inspection:

`Type Testing

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

Type Tests Fibre Optic Cable

TABLE-4

S. No	Test Name	Test Procedure
1	Water Ingres Test	(IEC 60794-1-F5/EIA 455-82B) Test duration:24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning: 72 hours, Test duration: 24 hours
3	Crush test	IEC 60794-1-E3/EIA 455-41)
4	Impact test	(IEC-60794-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A)-2 cycles

Type Tests Fibre Optic Cable

TABLE-5

S. No	Test Name	Acceptance Criteria	Test Procedure
1	Attenuation	As per TS	IEC 60793-1-40 or EIA/TIA 455-78A
2	Attenuation Variation with wavelength		IEC 60793-1-40 or EIA/TIA 455-78A
3	Attenuation at Water Peak		IEC 60793-1-40 or EIA/TIA 455-78A
4	Temp Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 or EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend Performance)		IEC 60793-1-47 or EIA/TIA 455-62A
6	Mode Field dia.	As per TS	IEC 60793-1-45 0r EIA/TIA 455-164A/167A/174
7	Chromatic dispersion		IEC 60793-1-42 or EIA/TIA 455-

			168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 or EIA/TIA 455-176
10	Core-Clad concentricity error		IEC 60793-1-20 or EIA/TIA 455-176
11	Fibre Tensile proof testing		IEC 60793-1-30 or EIA/TIA 455-31B

Factory Acceptance Testing

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

Factory Acceptance Tests on Underground Fibre Optic Cable

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

8.52.10 PLB HDPE PIPE and ACCESSORIES

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

Construction of PLB HDPE pipe

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

General

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

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

b) ASTM D 1693/ ASTM D 638/ ASTM D 648/ ASTM D 790 / ASTM D 1712/
ASTM D 2240/ ASTM D 4565 / ASTM F 2160/ ASTM G 154
c) TEC-spec no. GR/CDS-08/02/NOV-04(including all amendments)-HDPE pipe for use as duct for optical fibre cable.

Material

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

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

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

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

(iv) The ash content of the colour master batch shall not be more than 12% when tested as per method detailed below:
Test Method for ash content: About one gram of the sample under test shall be taken and dried at 105°C for two hours in a platinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600±50°C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.

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

a) Density (outer and inner layer): 940 to 958kg/m3 at 27°C. The density of completed PLB HDPE shall not be differ by more than 0.003gms/cc by this value when tested as per IS:2530 or IS:7328.
b) Melt Flow Rate (MFR): 0.2 to 1.1 g/10 minutes at 190°C & 5 kg load: when tested as per IS:2530. The MFR of the outer layer of the completed PLB HDPE pipe shall not differ by more than 30% of this value.
c) Tensile Strength at Yield: 20 N/mm2 minimum, when tested as per ASTM D 638, Type-IV specimens
d) Elongation at break: >600%, when tested as per ASTM D638, Type-IV specimens
e) Flexural Modulus at 1% strain: 690 N/mm^2 minimum, when tested as per ASTM D 790.
f) Hardness, Shore-D: Between 60 and 65 units, when tested as per ASTM D 2240
g) Heat Deflection Temperature at 45 g/mm2: 65ºC minimum, when tested as per ASTM D 648.
h) Environmental Stress Crack resistance, when tested with 10% Igepal, CO 0630 Solution 50ºC: 96 hrs., when tested as per ASTM D 1693, No cracks.
i) Weathering in artificial (UV) light (Specimens shall be as per ASTM D 638 Type-IV) and cut from compression moulded sheet. After exposure for 720 hrs., Tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength obtained at above.
j) OIT (in Aluminium Pan): 30 minutes minimum, when tested as per standard
k) UV Stabiliser Content: Hindered Amine Light Stabliser minimum 0.15%, when analysed as per FT-IR method.

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

Dimension of pipe

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

Accessories of PLB HDPE pipe

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

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

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

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

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

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

Workmanship

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

Marking

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

i) Owner's Name with logo
ii) Manufacture's name or trade mark
iii)Year of manufacturing
iv) Type of PLB HDPE pipe and size
v) Running length marking

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

Type Test

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

Telecommunication, according to relevant TEC for the proposed PLB HDPE duct meeting the specified requirement.

Factory Acceptance Testing:

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

8.52.11 Installation of Underground Fibre Optic Cable System

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

8.52.12 Installation of PLB HDPE Pipe

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

a. PLB HDPE Pipe shall be laid in a flat bottom trench free from stones, sharp edged debris.
b. The Pipe shall be placed in trenches as straight as possible. Minimum bending radius of pipe and fibre optic cable shall always to be taken into account.
c. The ends of pipes shall always be closed with end plugs to avoid ingress of mud, water or dust i.e. all pipe opening shall be sealed to avoid entry of foreign material.
d. The pipes shall be joined tightly & properly through plastic couplers and the joint shall be smooth and free from steps. The joints shall be made properly so that it passes the duct integrity test specified in this section. All joints shall be assembled with proper tools only.
e. Coupler shall not be placed along the bend portion of the pipe
f. Cable sealing plugs shall be provided at all manhole locations and at locations cable is coming out of the pipe and empty pipe ends i.e., all pipe openings shall be sealed to avoid entry of foreign objects.
g. PLB HDPE pipes shall be installed in a manner that fibre optic cable can be pulled, blown, de-blown without damaging the fibre optic cable due to stresses. The Contractor shall all joints inspected before carrying out the backfilling, by a representative of Owner/Employer. Joints shall be visually inspected and checked for tightness.

8.52.13 Reinstatement

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

8.52.14 Installation of GI Pipe

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

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

8.52.15 Underground Fibre Optic Cable Installation

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

a. The Optical Fibre Cable Drums shall be handled with utmost care. The drum shall not be subjected to shocks by dropping etc. They shall not be normally rolled along the ground for long distance and when rolled, shall in the direction indicated by the arrow. The battens shall be removed only at the time of actual laying.
b. A blowing machine in association with an appropriate compressor shall be used for blowing.
c. Temporary blowing chambers (if required) shall be constructed and then backfilled after blowing operation is completed.
d. Locations along the route, which provide easy access points for blowing machine and compressor, shall be determined.
e. Before starting the cable blowing, PLB HDPE pipe shall be checked for obstacles or damage. Checking shall be done by using a proper sized mandrel.
f. Always blow downhill wherever possible.
g. Multiple blowing machines may be used in tandem if so required.

h. Care must be taken not to violate the minimum bending radius applicable for the fibre optic cable. Tension in the cable during laying shall not exceed tension limit of the OFC. Installation by pulling may be permitted by the Employer only in specific cases where installation by blowing is not feasible on specific approval from the Employer. In case pulling is used, the pulling speed shall be determined considering the site condition. While installing the cable, excess length of about 10 meters shall be stored at each joint location for each side. Excess length of 10 m shall be kept at one ends of a road crossing culvert crossing and 20 meters at one end of bridges. However, exact excess lengths and manhole locations shall be finalised during detailed engineering depending upon the site requirement.

8.52.16 Trenchless Digging

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

Contractor's Scope of Work for Trenchless Digging

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

(a) Identify, provide and transport all equipment to the locations along the route as per the requirement to install PLB HDPE pipe by trenchless digging method.

(b) Excavation and backfilling of entry and exit pits.

(c) Detection and protection of existing underground facilities of other utilities along the route.

(a) Installation of 40 mm PLB HDPE pipe along the specified route by trenchless digging method and joining of PLB HDPE pipe by plastic coupler and sealing of PLB HDPE pipe at both ends by end plugs.

(b) Installation of manholes, termination of PLB HDPE pipes into the manholes and sealing of PLB HDPE pipes at the manhole entry as per approved drawings.

(c) Providing all plants, tools and tackles, consumables, marking and fencing required for the execution of the work as per the best engineering and safety practices.

(d) Maintain all lights, guards, plates, safety measures, sign boards etc. When and where necessary and/or required by the Owner/Employer or by any other statutory authority for the protection of works and/or for the safety and convenience of the public or the workers at the installation sites.

(e) Arrange electricity by arrangement of generators or other means at the site wherever required.

(f) Arrange construction water at the sites.

(g) Intimation to road maintenance agency, traffic police, other concerned utilities as necessary.

(h) Testing and inspection of installed PLB HDPE pipes and manholes.

(i) Rectifications, re-digging and re-installation of PLB HDPE pipes in case of problem during testing and fibre optic cable blowing/pulling.

As Built Drawings/details

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

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

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

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

8.52.17 Site Acceptance Testing (SAT)

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

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

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

a. Depth Check: One sample every 200 mtrs, Contractor shall prepare a sample pit at a location identified by the Employer. Depth of each item, warning tape, no. Of warning bricks (if applicable), pipes, cable etc. Shall be measured. Depth shall be as per technical specifications and shall correspond to recorded measurements.
b. Crossings: 10% of each type, visual inspection for checking conformance with drawings, thickness of Concrete, RCC Hume Pipe and GI pipe.
c. Manholes: As per technical specifications.

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

SAT for Underground Fibre Optic Cable

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

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

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

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

Table 6: Fibre Optic Cable Pre-Installation Testing

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

Table 7: Fibre Optic Cable Splice Testing

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

Table 8: Fibre Optic Cable Commissioning Testing

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

SAT for PLB HDPE pipe

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

Duct cleaning (Sponge test)

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

Crush and deformity test

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

8.52.18 Documentation

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

(a) As built drawing of the route indicating the distance from road centre, OFC drum length, location of other utilities, link Q, OFC loop length, name of the road, sections and positions of PLB HDPE pipes, couplers, warning bricks/stone, manholes, G.I. pipes, RCC pipes, joint box, conduits, bends, trays, optical fibre cable loop lengths in manholes etc.

(b) Depth of PLB HDPE pipe in various sections of the route executed through open trenching.
(c) Sections of trenching digging executed through various methods.
(d) Specific deviation w.r.t. the installation and supply items, if any, from the technical specification. If there is no deviation, either explicit or implicit, the Contractor will provide a certification to this effect.
(e) Without submission of the above documentations, the Site Acceptance Testing of various items as described above will be deemed to be incomplete.

8.52.19 Miscellaneous Jobs

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

Routing of Cables inside building.

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

Installation of PLB HDPE pipe on wall

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

8.52.20 INSPECTION & TESTING

Type Testing

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

Factory Acceptance Tests

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

8.52.21 System Maintenance

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

8.52.22 Documentation

The documentation provided shall include the following:

(a) Detailed list of the deliverables
(b) Description of the products
(c) Technical particulars
(d) Installation manuals
(e) Maintenance manuals

(f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality

8.53 SPECIFIC TECHNICAL PARTICULARS FOR 33 KV XLPE CABLE

Sl.No.	Particulars	Details
1	Description of Cable	ARMOURING: ARMOURED CORE MATERIAL: COPPER INSULATION: XLPE NOMINAL AREA: As per BoQ. NO. OF CORE: Single Core SHEATHING MATERIAL: EXTRUDED PVC, INNER & OUTER VOLTAGE GRADE: 33KV
2	Highest system voltage	36 KV
3	Voltage Grade	19/ 33KV
4	Earthing System	Effectively earthed
5	Frequency	50 Hz
6	Size of Cable	As per BoQ
	No. of Core	1C
7	Rated Power Frequency Withstand Voltage (1 min)	70 KV (rms)
8	Impulse withstand BIL (1.2/ 50/ micro Sec) Line to earth	±170 kVp
9	Rated short time withstand current	31.5 KA (rms) for 1 sec
10	Rated peak withstand current (1 sec)	78.75 KA
11	No of phase per Ckt	3
12	Maxm.Conductor temp	90 degree C at maxm. continuous current
13	Maxm. Permissible short circuit Temperature	250 degree C for one second
14	End Sealing	H.S. Caps
15	CABLE DETAILS : CONDUCTORS	
i	Conductor material	Plain un-tinned annealed copper
ii	Conductor Shape	Compacted circular.
iii	Conductor Screen	Extruded, Cross-linked, semi conducting compound of suitable thickness. Semi conducting separator tapes with 50% overlap to be applied between conductor and conductor screen.
iv	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16	INSULATION	
i	Insulation material	XLPE
ii	Insulation thickness	8.8 mm (Nominal thickness)
iii	specified insulation	1x1012 ohm cm

	resistance at 900C	
iv	Insulation Screen: Type & Material	Freely strippable (with heat) type extruded non-metallic semi conducting compound followed by copper metallic tape with minimum 25 % overlapping.
16	Resistivity of the semiconducting compound	Max 500 Ohm-meter
17	Longitudinal water barrier Material	Layer of semiconducting tape with suitable water swellable absorbent with 50% overlap.
18	Overall sheath	Extruded black HDPE (TypeST7) with anti termite and anti rodent treatment.
19	Coating of outer sheath	A hard baked layer of graphite or semi conducting layer shall be applied over the outer sheath as outer electrode for testing the sheath.
	Armouring	Armoured
20	TESTS	
i	Type Test	All tests as per specifications IEC Standards.
ii	Routine Test	All tests as per specifications IEC Standards.
iii	Acceptance Test	All tests as per specifications IEC Standards.
iv	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
21	Bending Radius	The minimum bending radius of XLPE insulated cables as follows: Cable: Bending radius Single Core: 25xD D – diameter of overall conductor.

8.54SPECIFIC TECHNICAL PARTICULARS FOR 66KV, 132 KV & 220KV XLPE CABLE

SI.No.	ITEMS	PARTICULARS		
1	Description of Cable	Stranded single core compacted copper core screening by a layer of semi conducting tape followed by a layer of semiconducting compound as conductor screen, XLPE insulation, insulation screening with semiconducting compound extruded directly over the insulation, (semiconducting conductor screen, XLPE insulation, semiconducting insulation screen-all in one triple extrusion process), longitudinal sealing by a layer of water swellable semiconducting non woven tape over insulation screen, followed by radial sealing (metal sheath of Corrugated Aluminum),and overall extruded black HDPE Sheathed (TypeST7).		
2	Highest system voltage	72.5KV	145KV	245KV

3	Voltage Grade	36/66KV 76/132KV 127/220KV
4	Voltage variation	+10% and -12.5%
5	Frequency	50 Hz
6	Frequency variation	±3%
7	Power frequency withstand voltage	90KV rms for 30 minutes 190 KV rms for 30 minutes 318KV for 30 minutes
8	Lightning impulse withstand voltage	±325KVpeak 650KVpeak 1050peak
10	No of phase per Ckt	3
11	Earthing system	Effectively earthed
12	Size of Cable	As per BoQ
13	Max. in Conductor Temp.	90ºC at maximum continuous current.
14	Fault level	31.5KA for 1 second 40Ka for 1 second 50KA for 1 second (considering parallel path of lead sheath and screen copper for metallic screen)
15	Maximum permissible short ckt temperature.	250ºC for one second.
16	CABLE DETAILS CONDUCTORS	
16.1	Conductor material	Plain un-tinned annealed copper.
16.2	Conductor Shape	Compacted circular.
16.3	Conductor Screen	Extruded, Cross-linked, semi conducting compound of suitable thickness. Semi conducting separator tapes with 50% overlap to be applied between conductor and conductor screen.
16.4	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16.5	Insulation	
	a) material	XLPE
	b) specified insulation resistanceat 900C	1x1012 ohm cm
16.6	Insulation Screen: Type & Material	Extruded semi conducting compound.
16.7	Resistivity of the semiconducting compound	Max 500 Ohm-meter
16.8	Longitudinal water barrier Material	Layer of semiconducting tape with suitable water swellable absorbent with 50% overlap.
16.9	Radial moisture barrier Material	Seamless or seam welded Corrugated Aluminum sheath with anti-corrosive material.
16.10	Overall sheath	Extruded black HDPE (TypeST7) with anti termite and anti rodent treatment.

16.1 1	Coating of outer sheath	A hard baked layer of graphite or semi conducting layer shall be applied over the outer sheath as outer electrode for testing the sheath.
17.	Approximate Length of cable in a drum	500 metres with a tolerance range of ±5% or as per requirement.
18	Bending Radius	The minimum bending radius of XLPE insulated cables as follows: Cable: Bending radius Single Core: 25xD D – diameter of overall conductor.
19	TESTS Applicable standards	IEC60840 IEC62067
19.1	Type Test a) whether previous test reports will be sufficient b) whether sample to be Type tested against this order.	All tests as per specifications IEC Standards Yes, if done on identical cable. No, if done on identical cable.
19.2	Routine Test	All tests as per specifications IEC Standards.
19.3	Acceptance Test	All tests as per specifications IEC Standards.
19.4	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
20	INSTALLATION, TERMINATION AND JOINTS	
21	Ambient temperature Ground temperature Thermal resistivity of soil	450C 300C 1500C cm/Km
22	Laying Configuration	Trefoil formation.
23	Depth	1.5 m below ground level.
24	Termination	
25	Type	AS per requirement
26	Joints Required	No
27	Earth Link Boxes Required	Yes. In both end and at joints as per cable bonding system
28	Surge Suppressor Required	Yes
29	Type Bonding ‘	Single end bonding/ cross bonding

SECTION -9

TECHNICAL SPECIFICATION FOR SURGE ARRESTORS

TECHNICAL SPECIFICATION FOR SURGE ARRESTERS FOR 132KV & 33KV SYSTEMS

9.1.0 SCOPE

This Section covers the specifications for design, manufacture, laboratory testing before dispatch at Station, delivery at site, erection, testing and commissioning of class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with fittings & accessories for 132 kV and 33 kV systems.

9.2.0 STANDARDS

The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 / IEC: 60099-4 unless otherwise specifically specified in this Specification.

9.3.0 GENERAL REQUIREMENT

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

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

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

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

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

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

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

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

I. 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.

9.4.0 ARRESTOR HOUSING

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

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

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.

Sealed housings shall exhibit no measurable leakage.

9.5.0 FITTINGS & ACCESSORIES

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

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.

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

9.6.0 SURGE MONITOR

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.

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.

9.7.0 TESTS

9.7.1 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.

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

9.7.2 Galvanization Test

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

9.8.0 NAME PLATE

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.

9.9.0 PRE-COMMISSIONING TESTS

Contractor shall carry outfollowing 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 forconducting these tests alongwith calibration certificates and shall furnish the list ofinstruments 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.)

9.10.0 TYPE AND RATINGS

SL. No.	Particulars	Voltage Class	
		145 kV	36 kV
1	Rated voltage of arrester, kV	120	30
2	Continuous operating voltage, kV	102	25
2	Rated frequency, Hz	50	50
3	Nominal discharge current of arrester, kA	10	10
4	(i) Min. switching surge residual voltage (2kA), kVp	280 (1 kA)	-
	(i) Max. switching surge residual voltage (500 kA), kVp	-	-
5	Maximum residual voltage at,		
	(i) 5 kA nominal discharge current, kV (peak)	310	85
	(ii) 10kA nominal discharge current, kV (peak)	330	90
	(iii) 20kA nominal discharge current, kV (peak)	385	100
	(iv) Steep fronted wave residual voltage, kV (peak)	-	-
6	One minute power frequency withstand voltage of arrester housing, kV (rms)	275	70
7	1.2 / 50 μ second impulse withstand voltage of arrester housing, kV (peak)	650	170
8	Switching impulse withstand voltage (250/2500 micro second) of arrester housing dry and wet, kV (peak)	-	-

9	Creepage distance of insulator housing (mm)	4495	1116
10	Line discharge class	3	2
11	Short time current rating, kA for 3 sec	40	31.5
12	Pressure Relief Class	A	A

SECTION- 10
132kV GIS SUB-STATION SYSTEM

1. GENERAL

The GIS manufacturer shall design, manufacture, test, deliver and guarantee the GIS components and services as defined in this Technical Specification.The complete GIS based on the Single Line Diagram shall be provided for connection to Power Transformers/Reactors/Lines feeders with associated circuit breaker, disconnectswitch and grounding switch (maintenance and high speed), instrument transformers, and surge arrestor (if applicable) etc.

Important Note:

a) Arrangement of authorized technical personal of existing Sieyuan make GIS (including arrangement of tools & consumables required to open existing GIS) at existing 220/132kV Amingaon GIS is in the scope of successful bidder. No price implication will be borne by AEGCL.

b) Existing GIS Auto CAD file will be provided after issue of LoA to the successful bidder.

c) Detail shutdown schedule and execution plan may be submitted by the successful bidder after issue of LoA

d) Any damage partial or full of the existing GIS equipment during coupling process will be the responsibility of the EPC contractor/OEM.

   Any damage partial or full of the existing GIS adapter and both existing buses after coupling process will be the responsibility of the EPC contractor/OEM till the defect liability period

e) Design Temperature shall be 50 deg centigrade and Nominal Current shall be 3150A as per BID.

f) 132kV VT is not in the scope of the tender.

2. GENERAL CHARACTERISTICS

2.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its constituent parts. It should be designed for indoor application with meteorological conditions as specified.

2.2 All parts of the busbar, switchgear and the bus ducts (for both indoor and outdoor applications) shall be as mentioned below:

400kV GIS	Single phase enclosed
220kV GIS	Single Phase/Three Phase enclosed
132KV GIS	Three Phase enclosed

2.3 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirements hall deemed to be included or as per existing SLD provided with the tender.

3. REFERENCE STANDARDS

The GIS offered shall confirm to IEC 62271-203 and other relevant IEC standard except to the extent explicitly modified in the specification and shall be in accordance with requirements pecified in general design criteria

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening:

IEC 62271-1 : High-voltage switchgear and control gear Part 1: Common specifications

IEC 62271-203 : High-voltage switchgear and control gear Part 203: Gas- insulated metal-enclosed switchgear for rated voltages above 52 kV Circuit-breakers:

IEC 62271-100 : High-voltage switchgear and control gear Part 100: Alternating- current circuit breakers

IEC 62271-101 : High-voltage switchgear and control gear Part 101: Synthetic testing Disconnectors, earthin switches.

IEC 62271-102 : High-voltage switchgear and control gear Part 102: Alternating- current dis-connectors and earthing switches Instrument transformers:

IEC 62271-303 : High-voltage switchgear and control gear – Use and handling of sulphur hexafluoride (SF6)

IEC 61000 : Electromagnetic compatibility (EMC)

IEC 60060 : High voltage test techniques

IEC 60071 : Insulation co-ordination

IEC 60255 : Electrical relays

IEC 60265 : High voltage switches

IEC 60270 : High-voltage test techniques - Partial discharge measurements

IEC 60376 : Specification and acceptance of new sulphur hexafluoride

IEC 60480 : Guide to checking of sulphur hexafluoride (SF6)

IEC 60529 : Degrees of protection provided by enclosures (IP Code)

IEC 60815 : Guide for the selection of insulators in respect of polluted conditions

IEC 61869/60044/60185/60186 : Instrument transformers

IEC 60364 / 60479 / 60621 / IEEE std. 80/CIGRE 44: Standards for station grounding. CENELEC/SVDB : Pressurevessel code

IEC 693 : Seismic Design

IEC 62271-207 Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV

IEC 60137 Bushings for alternating voltages above 1000 V

IEC 62271-209 Cable connections for gas-insulated switchgear

IEC 60099 -1/4 Non-linear resistor type arresters for AC systems

IEC 60439 Factory-built assemblies of low-voltage switchgear and control Gear.

IEEE 80 2013 IEEE Guide for Safety in AC Substation grounding.

CIGRE-44 Earthing of GIS- an application guide.

IEC 62271-211 Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

Cable Connections:

IEC 62271-209: High-voltage switchgear and control gear Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and dry- type cable-terminations

Outdoor Bushings:

Iec 60137: Insulated Bushings for Alternating Voltages Above 1000 V Transformer Direct Connection:

Iec 61639: Direct Connection Between Power Transformers and Gas-Insulated Metal-Enclosed Switchgear for Rated Voltages Of 72.5 Kvand Above.

Surge Arresters:

Iec 60099-4: Surge Arresters Part 4: Metal-Oxide Surge Arresters Without Gaps for A.C. Systems SF6-Gas:

IEC 60480: Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use

IEC/TR 62271-303: High-voltage switchgear and control gear Part 303: Use and handling of sulphur hexafluoride (SF6) Local Control Cubicles:

IEC 61439 -1: Low-voltage switchgear and control gear assemblies Part 1: General rules EMC. IEC 62271-1: High-voltage switchgear and control gear Part 1: Common specifications

Enclosure CENELEC standard mentioned above.

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The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professionals ocieties as may be approved by the Employerand themanufacturer shall list all such applicable standards, codes etc. The manufacturer shall supply those standards (soft copy) as and when required by AEGCL without any extra cost borne to AEGCL.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein inregard there to.

Modular Design

Housings and expansion joints together form the pressure-resistant enclosure of the switchgear. The housings are made of cast or welded aluminium, the expansion joints of high-grade steel and the covers of steel or aluminium. The switchgear modules are single-phase or three-phase encapsulated.

The manufacturing and testing of the housings are state-of-the-art technology. Each, housing is subject to a pressure and gas tightness test and complies with the requirements of the relevant CENELEC standard.

Surface Treatment Steel (covers):

Indoor structure: Hot galvanised or painted Outdoor structure: Hot galvanised and painted High-Grade Steel (expansion joints):

Indoor Pre-treatment: none Paint work: none

Outdoor Pre-treatment: degrease

Paint work (Painting Procedure shall be as per Type Tested Design): same as housings of cast aluminium

Cast-Aluminium:

Pre-treatment (indoor and outdoor): Sand-blast or degrease alkaline

Internal surfaces (cast-aluminium): As per manufacturers type tested design Internal surfaces (aluminium wrought alloy): without surface treatment

External surfaces: material description: high-resistant 2-component polyurethane paint Shade: As per manufacturers type tested design

Gas

Gas compartments, monitoring of gas compartments:

SF6 serves as insulation for the enclosure of several separately-sealed gas compartments

Static filters in all gas compartments – with single-phase encapsulation for each phase for single phase encapsulation design or the offered GIS is of 3Phase encapsulated as per existing GIS.- absorb moisture and decomposition products; the filter material is placed in filter bags which are supplied in airtight cans all gas compartments are equipped with rupture diaphragms and, if necessary, with gas diverter nozzles; these nozzles are arranged in a way that, if the rupture diaphragm bursts, the gas flow is guided away in a direction not unnecessary hazardous to either personnel or equipment the modules of circuit-breakers, voltage transformers, cable connection module and surge arresters form separate gas compartments. The disconnector gas compartment can contain other device like earthing switch the switch operating shafts are supported and provided with lip seals against pressure and vacuum loss in such a way that during the evacuation process before commissioning no air can penetrate and no SF6 can escape during operation; the leakage rate is less than 0.5 % SF6 per year and gas compartment.

The gas pressure is monitored by density monitors with indication; density monitors are installed directly at the gas compartment they monitor.

4. GENERAL DESIGN AND SAFETY REQUIREMENT

4.1 The GIS shall bedesigned, manufactured and tested in accordance with the best international engineering practices under strictquality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectricstress and insulation coordination etc. shall be maintained during design, selection of raw material, manufacturing processetc. So, that the GIS provides long life with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

4.2 The GIS assembly shall consist of separatemodular compartmentse. g., CircuitBreaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitionsso as to minimize risk to human life, allow ease of maintenance and limit the effects of gasleaks failures & internal arcs etc. These compartments shall be such that maintenance on onefeeder may be performed without de-energising the adjacent feeders. These compartmentsshall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing with in the enclosure sunderworstoperating conditions, thus providing controlled pressure relief in the affected compartment.

4.3 The switchgear, which shall be of modular design, shall have complete phase isolation. Theconductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is atleast 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

4.4 All circuit breakers, disconnect switches and other component of GIS having identical rating shall have identical and interchangeable parts and operating mechanism as far as possible.

4.5 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimized isturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Further, it is prohibited to work adjacent to agas compartment while it is fully pressurized on the other side. For such cases, the gas pressure in the adjacent compartments needs to be reduced.

Note: AEGCL will accept that the offered GIS is of modular design and the Bus side earth switch offered is not placed in separate compartment. However, the offered GIS must meet the required service continuity requirements.

The switchgear must be sectionalized, with gas tight barriers between sections or compartments. The sections shall be designed to minimize operational shut down when the gas pressure is reduced due to Leakage or for maintenance purposes. Also, to minimize the quantity of gas that has to be evacuated and recharged before and after maintaining any item of equipment.

Continuous bus lengths without gas segregation shall not be acceptable for any voltage level.

Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section.

The gas system proposed shall be submitted with the proposal. External fixtures shall be of non-corrosive material and be capped wherever required.

For the purpose of gas monitoring and maintenance, the GIS shall be provided with gas density monitoring device along with temperature compensated gas density switch having two stage contacts in each gas compartment. Pressure relief devices shall be used wherever required.

Support insulators shall be used to maintain the conductors and enclosure in proper relation.

Barrier insulators which are employed to isolate gas compartments as well as support insulators shall be manufactured from high quality epoxy resin, free of all voids and be designed to reduce the electrical stress on the insulators to a minimum. The support insulator shall have holes on both sides for proper flow of gas.

The mechanical strength must be sufficient to ensure the conductor's space requirements and clearances when short circuit faults occur. In addition, the gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum gas pressure differential under normal operating condition and maximum pressure differential with one of the adjacent enclosures at three times operating gas pressure and the other at atmospheric pressure for five minutes. Its safety factor shall be as per IEC.

Tests shall be carried out during the manufacturing of the switchgear to ensure that all insulators are free of partial discharge at a voltage which is at least 10% higher than the rated voltage.

Gas System

The GIS shall be furnished with sufficient sulphur hexa-fluoride (SF_6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. During commissioning, the dew point of SF_6 gas shall be measured and documented. Maximum water content of SF_6 -gas in GIS, within guarantee period:

CB ≤ 150 PPM (volume) Others ≤ 500 PPM (volume)

The Gas loss of the switchgear shall be in no case higher than 0.5% per year.

Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O-ring type. The material and method of sealing used shall be stated in the tender.

Gas filters / treatment

Each gas compartment shall be fitted with gas filters, driers or desiccants for the absorption of moisture and the gaseous products of switching. The filter shall be effective for the duration of time between major overhaul. It shall be possible to replace the active material of the filter without extensive dismantling. The absorbent shall be located in an easily accessible location. The tenderer shall indicate the detail and type of filters used in the various gas sections.

Gas Monitoring Devices

Temperature-compensated gas density monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and online monitoring (Display at SAS) of the density of the gas. The monitoring device shall have two alarm settings. These shall be set so that:

First stage: Advanced warning can be given that the gas density is approaching an unacceptably low level Second stage: The relevant GCB can be locked for tripping/ closing.

SF6 Gas Treatment

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. Normally closed valve shall be provided to facilitate filling and recharging. In all gas compartments permanent efficient filters and drying agent shall be at least effective for the duration of time between major overhauls. The filters shall be capable of absorbing the by-products of SF6 gas during interruption.

4.6. The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures. GIS should be suitably sub-divided into individual arc and gas-proof compartments preferably for:

1) Bus bars
2) Intermediate compartment
3) Circuit breakers
4) Feeder Disconnect Switch
5) Voltage Transformers
6) Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
7) Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor (if applicable)

4.7. Service continuity requirement:

The GIS equipment with the given bus switching arrangement is divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be de-gassed.

Working conditions, method statements and procedures are to be furnished by the GIS manufacturer in order to ensure equipment and operating personnel's safety and to achieve following Service continuity conditions to the extent possible:

4.7.1. For One & half breaker bus switching scheme during a fault in CB compartment, No bus bar and feeder is permitted out of service during maintenance and repair/replacement.

4.7.2. For Double Main bus switching scheme during a fault in CB compartment, No bus bar permitted out of service during maintenance and repair/replacement.

4.7.3. During a fault in GIS compartment other than CB compartment, maximum one bus bar and/or one feeder permitted out of service during maintenance and repair/replacement.

Repair

In case of any internal fault in the bus bar or bus bar dis - connector, circuit breaker, grounding switches etc., repair works must be possible with at least one busbar in service. In case of any type of fault in any section of the line bay, transformer bay or bus coupler bay modules, repair works must be possible.
Any failure shall be immediately signaled by the systems inherent self-supervision with clear description of the nature and the location of this failure. Generally, any failure shall have impact only on the direct related devices and the rest of the substation shall remain in normal operation.

Removal of Components

The GIS shall be designed so that any component of the GIS can be easily removed. As minimum flexibilityin the layout arrangement, it shall be possible to remove the circuit breaker with both bus bar remaining in service and it shall be possible to remove the dis connector of the bus bars, with one bus bar remaining in service.

4.8. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition. This shall be validated with Type Test.

4.9. Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the
equipment. Inspection windows (View Ports) shall be provided for Disconnect Switch and both type of earth switches i.e. Maintenance and fast operating.

4.10. The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators. Field welding of the conductor is not acceptable.

4.11. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

4.12. The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning.

4.13. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve, rupture discs and safety diaphragm. The filters shall be capable of absorbing any water vapor which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

4.14. The switchgear when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions, shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external/internal reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

4.15. The thermal rating of all current carrying parts shall be minimum for three sec. for the rated symmetrical short-circuit current.

4.16. The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

4.17. The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and employer.

The arrangement of the equipment offered must provide adequate access for operation, testing, Repair and maintenance.

4.18. All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays and LCC panels.

4.19. It should not be possible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.

4.20. In general, the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

4.21. The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation for 220 kV and above.

4.22. The enclosure shall be of continuous design and shall meet the requirement as specified in of IEEE 80 2013 (special considerations for GIS).

The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

4.23. The fabricated metal enclosure shall be of Aluminium alloy having high resistance to corrosion, low electrical losses and negligible magnetic losses. The manufacturer shall clearly indicate the material used for different GIS enclosures in the GTP/design document during approval. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall confirm to metric system. The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

4.24. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro-Tesla on the surface of the enclosure.

4.25. The switchgear shall have provision for connection with ground mat risers through copper connections. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

4.26. For 220 kV and above voltage class GIS, wherever required, stairs, fixed ladder, platforms, and walkways for operation and maintenance access to the operating mechanism and monitoring devices should be provided to permit access. The structures shall be hot-dipped galvanized steel. All structures, stairs, platforms, and walkways shall conform to the relevant occupational health and safety regulations and designed in accordance with the latest industry standards and guidelines. The platforms and walkways shall have anti-skid surfaces that can be walked on. Handrails shall be provided where necessary. The GIS supplier shall provide 3-D arrangement drawing to show the location of equipment and access to it.

4.27. In addition to above suitable portable scissor lift shall be provided for access of distant portion of GIS installation. (Scope of EPC, no price implication will be borne by AEGCL.)

4.28. New Gasket, sealant and desiccant shall be installed for permanent sealing of all site/field assembled joints. No gaskets are to be reused for any permanent seal broken or disturbed in the field/site.

4.29. The enclosure & support structure shall be designed such that person of 1780 mm in height and 90 Kg in weight is able to climb on the equipment for maintenance.

4.30. The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

4.31. Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

Gas Insulating System:

i) Loss of Gas Density

ii) Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System:

i) Low operating pressure

ii) Loss of Heater power

iii) Loss of operating power

iv) Loss of control supply

v) Pole Discordance. (Pole discordance is not applicable for 3- phase gang operated circuit breaker)

4.32. The equipment will be operated under the following ambient conditions (or as defined in the section project):

a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.

b) The humidity will be about 95% (indoors)

c) The elevation is less than 1000 meters

4.33. Temperature rise of all current carrying parts and enclosures shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions as specified.

4.34. All cabinet heaters shall be rated for 240V AC (1-phase) supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

4.35. Bellows or Compensating Units:- Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and for differential thermal expansion between the conductors and the enclosures. The bellows metallic (preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction may be provided and shall be of following types:.

1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.
3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
5. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

4.36. Indication and verification of switch positions: Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

4.37. Pressure relief device: Pressure relief devices shall be provided in the gas sections to protect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Automatic external pressure relief devices shall be incorporated in the basic design as a precaution against bursting of enclosure. Internal pressure relief devices shall not be acceptable. The bursting pressure of the relief device shall be effectively coordinated with the rated gas pressure and the pressure rise due to arcing to avoid any mal-operation in normal operating conditions. Deflection devices shall be installed to ensure that personnel will not be endangered. Pressure relief shall be by means of a metallic bursting disc system with a preset opening pressure. For better gas tightness, bursting discs made of graphite or non-metallic material shall be avoided.

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided.

4.38. Pressure vessel requirements: The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the Pressure Vessel Code (ASME/CENELEC code for pressure Vessel.)

The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.

The metal enclosures for the GIS equipment modules shall be made from Aluminum alloy and tubular in construction. The tenderer shall state the material used for his particular design. All flanges shall be directly bolted together with good metallic contact to make enclosures equipotential.

Enclosures shall withstand normal and transient pressure in operation. They shall be designed and manufactured according to the related standards to safety and reliability of material, construction, welding technology and testing. Enclosures shall be designed to withstand any internal arc specified in IEC 62271-203.

The gas-filled enclosures shall comply to the pressure vessel code applied in the country of manufacturer and shall be suitable for purchaser's environmental condition.

4.39. Grounding: (Scope of EPC/OEM)

4.39.1. The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

4.39.2. The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure, GIS surge arrestor etc. to the ground bus of GIS.

4.39.3. The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, current transformers, voltage transformers, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected either internally or externally with copper bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

4.39.4. Each marshalling box, local control panel, power and control cable sheaths and other non- current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

4.39.5. The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

4.39.6. All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS. The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents due to by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The manufacturer shall provide suitable barrier of non-linear resistor/counter discontinued SF6/Air termination SF6/HV cable bushing etc. to mitigate transient enclosure voltage.

(a) Earthing of Main Circuits

To ensure safety during maintenance work all parts of the main circuit, to which access is required, shall be provided with facilities for connecting removable earthing device, after opening the enclosure, on the circuit element which is previously earthed via main earth switch.

(b) Earthing of Enclosure

The enclosure shall be connected to earth. All metal parts other than main and auxiliary circuits shall be earthed. Separate earthing strips to short circuit flanges and earth switches are not allowed. Earthing switches shall be connected to earth through enclosures. Individual earth leads for the earth Switches are not recommended. The continuity of the earthing circuits shall be ensured taking into account thermal and electrical stresses caused by the current they have to carry. Each of the earthing strips shall be connected to the main earthing mesh installed below the GIS, at two ends.

(c) Earthing of GIS

The earthing system shall be based on a multi-point design ensuring the protection in case of indirect contact (Touch or step voltages, in case of system fault) and transient phenomena in case of lightning or switching operations.

Earthing conductors shall allow fault with short circuit current for at least 3 sec. Separate ground strips to short circuit flanges and earthing switches are not allowed. Grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed.

EARTHING CONDUCTOR MAY VARY AS PER EARTHING CALCULATION AND THE SAME WILL BE DECIDED DURING DETAILED ENGINEERING. Corrosion factor shall be taken into consideration while performing earthing design calculations.

Equipotential Earthmat: (below the GIS)

When a fault current flows through the earthing connections into the soil, the enclosures, linked to the earthing circuits, are carried at the same potential as the earthing mat conductors but this potential is generally different from that on the soil surface.

In order to ensure the security of personnel, it is necessary to install an equipotential mat linked to the general earthing mat in the zones where metal enclosures and fixed accessories are accessible from the floor.

It is also necessary to provide an equipotential earthing mat in the zones where an emergency mechanical operation or a locking system is accessible from the floor. It is therefore possible to extend the equipotential mat to allow the operator to carry out his manoeuvres.

In order to ensure a good equipotential surface, each element of the equipotential mat must be connected to the general earthing network by the manufacturer.

This mat will be placed on the floor, all around the switch gears. It is not required in front of the control cubicles. If it is an oxidizing material, it should be hot dip galvanized.

The manufacturer must provide and specify this equipotential earthing mat. The location of the equipotential mat should be defined by the supplier for all the GIS and at places where:

-the enclosures are accessible for the floor.
-Manual operation of apparatus or locking system is located.
Five copies of equipotential earth mat drawings along with design calculations may be submitted for approval by the successful Tenderer.

4.40. UHF sensors for PD detection:

Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270. The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (APPLICATION GUIDE FOR SENSITIVITY VERIFICATION for UHF PARTIAL DISCHARGE DETECTION SYSTEM FOR GIS) and CIGRE task force TF15/33.03.05 (Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the coustic method). Offered numbers and location of UHF sensors shall be submitted based on above said criteria along with attenuation calculation for approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments.
However, adequacy of number of sensors and their location shall be verified at site as per recommendations of above CIGRE Document No. 654. In case during site testing, additional UHF sensors are required, the same shall also be supplied & installed to complete the technical requirement.
The calibration and frequency response of PD couplers shall be as per NGC Technical Guidance note TGN (T) 121, issue 1, 1997. Data sheet shall be submitted for the UHF couplers meeting this requirement.

Finish of Surface and Cleaning

The finish of interior surfaces of the GIS enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall not deteriorate when exposed to the SF6 gas and arc products, etc., that may be present in the enclosures. They shall not contain any substances which could contaminate the enclosed SF6 gas or affect its insulating properties over a period of time.
The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness. Before factory tests and packing for shipment, interior surfaces, insulators, barriers etc., must be thoroughly cleaned.

Supporting Structures

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied.
Access has to be considered in the design of the structures to all equipment of the GIS. It has to be possible to surround the GIS with the gas cart.

The specified stresses for outdoor equipment like wind, earthquake, snow, ice and thermal expansion due to current and sun radiation have to be considered.
Proper surface treatment for all parts especially in outdoor situation has to be considered. All steel members have to be hot-dipped galvanized according to relevant Indian/International standards for heavily polluted environment.

Auxiliary Contacts

Each equipment shall be furnished with adequate number of electrically independent contacts at user's disposal. They shall be wired to terminals located in the local control cabinet of the circuit breaker bay. Installation of auxiliary relays (contact multiplication) may be used to meet the overall control and protection requirements.

4.41. Gas Insulated Bus (GIB) layout:

GIB shall be designed based on the following criteria

(1) Maximum weight of gas in a gas tight section of GIB shall not exceed 400 Kg (for 400 kV)/ 250 Kg (for 220 kV & 132 kV).

(2) GIB shall be generally in horizontal layer. However, in exceptional circumstance GIB in vertical layers can be provided with the approval of employer.

(3) The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters

(4) The horizontal clearance between GIB and GIS building /any other building wall shall be preferably three (3) meters.

(5) The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.

(6) The GIB clear height outside the GIS hall in switchyard area shall be minimum 3.5 meter, so as not to obstruct easy access to GIB, movement of crane for maintenance work.

(7) Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.

(8) For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.

(9) GIS manufacturer as per their design shall preferably use maximum three standard straight horizontal outdoor bus duct lengths for entire GIS installation to optimize the spare requirement.

(10) Special anti-corrosive measures shall be taken in bus ducts as per site condition.

(11) Corrosion case of Sonapur

4.42. Extension of GIS

4.42.1. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

4.42.2. As the GIS is likely to be extended in future, during detailed engineering stage, the contractor shall make available the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.

4.42.3. The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remained isolated. Interface Module drawing with necessary detail shall be submitted for approval.

4.42.4. Further the contractor who is extending the existing GIS installation, it shall be his responsibility to provide interface module matching with the existing GIS interface module. The drawing of existing GIS interface/end piece module shall be provided by the employer. However, it shall be the responsibility of contractor to verify the existing details during site visit.

The Contractor shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract.

For any type of bus bar configuration, it shall be possible to extend the switchgear by adding future feeders as decided by the owner with at least one of the bus bar systems in service continuously and the existing feeders remaining in service continuously. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect.

4.43. SF6 GAS

The tender shall include the supply of all SF6 gas necessary for filling and putting in commercial operation the complete switchgear installation with recommended extra quantity (minimum 10% extra). The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC & should be suitable in all respects for use in the switchgear under all operating conditions. Necessary statutory clearances from concerned authorities for import of the Gas and for storage of the Gas shall be obtained.

The high-pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet latest Gas Cylinder Rules (PESO)

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for dew point and purity shall be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections of GIS during service. The method proposed shall have as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

The contractor shall also submit clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

4.43.1 SF6 gas monitoring devices and alarm circuits: Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic (ONLINE) monitoring of gas density. For offered GIS, the DM are such that the pressure status can be continuously monitored on the DM switches. In SCADA the pressure status (Not values) can be monitored online. A separate device shall be provided for each gas tight compartment so that it can be monitored simultaneously as follows:-

6. Compartment/Sl.No.	Compartments except CB	Circuit Breaker compartments
1	**“Gas Refill level:** This will be used to annunciate the need for the gasrefilling. The contractor shall provide a contact	**'Gas Refill' level: This** will be used toannunciate the need for gas refilling. The contractor shall provide a contact
	For remote indication to SAS.	For remote indication to SAS.
2	**“SF6 low level”: This** will be used to annunciate the need for urgent gas filling. A contact shall be provided for remote indication to SAS	**“SF6 low level”:** This will be used to annunciate the need for urgent gas filling. A contact shall be provided for remote indication to SAS
3	**'ZoneTrip'level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.	**Breaker Block'level:** This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked. A contact shall be provided for remote indication to SAS
4	**Not Applicable**	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

4.43.2. **Gas Supply:** The contractor shall include the supply of all SF6 gas necessary for filling & putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

4.44. **Documentation**

The contractor shall prepare and submit to the employer, drawings, details that show the GIS design in order for the employer to verify the equipment conform to the specifications. The Design Document to be submitted for review and approval are as follows:

i. Design Review Document
ii. Single Line Diagram
iii. Gas Schematic Diagram
iv. GTP-Guaranteed Technical Particulars
v. GIS layout (Plan and Section) including 3D drawing
vi. GIS Component Drawings
vii. Interface modules drawing for GIS extension
viii. Rating and Name Plate Drawing
ix. GIS/LCC Schematics Drawing

x. Foundation loading plan and detail
xi. GIS Support Structure Drawing
xii. GIS platforms and Walkway Drawing
xiii. GIS grounding plan and details along with design calculation for GIS grounding
xiv. GIS key Diagram enlisting and marking each and every GIS Module clearly and separately identifiable (indoor and outdoor). This separately identified module shall be complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc.
xv. Method Statement along with sequential instruction for dismantling and assembling of all major components of GIS exhibiting service continuity requirement
xvi. Type Test Reports
xvii. Seismic Analysis Report
xviii. Study report of VFTO generated for GIS installation for 400 kV and above.
xix. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end
xx. The general arrangement drawing of Terminal connection arrangement to connect GIS duct to SF6/Oil bushing and duct mounting arrangement details
xxi. Gas handling procedure
xxii. The design & construction proposal of the building along with necessary information, data, and drawings according to the complete requirements
xxiii. Capacity calculation of EOT crane for GIS hall considering a factor of safety of 5
xxiv. Method statement/ procedure of ON-SITE high voltage testing with PD measurement and Switching Impulse test
xxv. **Additional CB data to be furnished during detailed engineering:**

i. Design data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 % fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
ii. Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.
iii. Contact Travel: Operating mechanism operating shaft travel and contact overlap of Circuit Breaker to be provided

xxvi. PD Monitoring System

a) The technical proposal for PDM system along with detailed design documentation.
b) Data sheet for the UHF couplers.
c) The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc., total numbers of offered UHF Sensors along with attenuation calculation.
d) Guaranteed Technical Particulars & Data Sheet for various components used in the PDM system.
e) Electromagnetic compatibility Test Reports.
f) List of critical spares.
xxvii. Installation and Operation & Maintenance Manual

Technical Specification of the High Voltage Components of GIS

6. CIRCUIT BREAKERS

6.1. **General:** SF6 gas insulated metal enclosed circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification .

6.2. Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing (as applicable) with an operating sequence and timing as specified. For 145kV GIS, CB shall be of three phase reclosing type only. (Note: Breaker disposition must be horizontal to provide higher mechanical stability and ease in maintenance. However, Type Tested Design may be accepted. Feasibility at site shall be checked by the OEM.)

6.3. **Duty Requirements:** Circuit breaker shall be C2 - M2- E2 class as per IEC 62271-100.
Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

6.4. **Pre insertion resister:** 400 kV circuit breakers for line bay (as per the provisions of bid proposal sheet) shall be provided with single step pre insertion closing resistors (wherever the requirement of PIR is explicitly specified so) to limit the switching surges to a value of less than 2.3 p.u for 400kV. PIR contacts should open immediately after closing of main contacts or At least 5 ms prior to opening of main contacts at rated air/gas pressure where the PIR contacts remain closed. The resistor shall have thermal rating for the following duties:

a. Terminal fault: Close.... 1 Min........ Open...... Close Open 2 min........ Close ....
1 Min Open Close Open.

b. Reclosing against trapped charges: Duty same as under (a.) above. The first, third and fourth closures are to be on de-energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. of opposite polarity.

c. Out of phase closing: One closing operation under phase opposition that is with twice the voltage across the terminals.

No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished during detailed engineering. The calculations shall take care of adverse tolerances on resistance values and time settings.

6.5. The circuit breaker shall be capable of:

1. Interrupting the steady and transient magnetizing current shall be as follows:

VoltageLevel	**TypeofTransformer**	**Rating(inMVA)**
400kV	**400/220kV**	**250to630**

	400/132kV	**160to315**
220kV	**400/220kV**	**250to630**
	220/132kV	**50to200**
132kV	**220/132kV**	**50to200**
	132/33kV	**10to50**

2. Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4
3. Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
4. Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.
5. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.
6. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).
7. Circuit breakers shall be able to switch in and out the shunt reactor as detailed below:

VoltageLevel	**Reactor Rating (inMVAR)**	**Max.riseofovervoltage(inp.u.)**
400kV	**50to150**	**2.3**
220kV	**25to50**	**2.3**

6.6. Total Break Time : The total break time shall not be exceeded under any of the following duties :

a) Test duties T10, T30, T60, T100 (with TRV as per IEC- 62271-100)
b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

The Contractor may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), pneumatic/hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

The values guaranteed shall be supported with the type test reports.

6.7. Constructional features :

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

6.6.1. If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.

6.6.2. **Contacts**: All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

6.6.3. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

6.6.4. Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

6.6.5. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. power frequency voltage across the breaker continuously)

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

6.6.7. Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for each substation covered under the scope.

6.6.8. Circuit Breaker shall be supplied with auxiliary switch having additional 10 NO (normally open) and 10 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired upto the local control cubicle.

6.6.9. The CO (Close-open) operation and its timing shall be such as to ensure complete travel/insertion of the contact during closing operation and then follow the opening operation

6.8. Operating mechanism

6.7.1. General Requirements:

a) Circuit breaker shall be operated by spring charged mechanism or hydromechanical spring mechanism. The mechanism shall be housed in a dust proof cabinet and shall have IP: 42 degrees of protection.

b) The operating mechanism box shall be strong, rigid, rebound free and shall be readily accessible for maintenance.

c) The operating mechanism shall be suitable for high-speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided.

f) 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.

g) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

6.7.2. Control

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch shall be provided in the breaker control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

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

6.7.3. Spring operated Mechanism (SPRING-SPRING)

a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.

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

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet &SAS .

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

j) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.

k) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.

l) An overload relay shall be provided for protection of the spring charging motor.

6.8. Controlled Switching Device (CSD):

6.8.1. 400KV Circuit Breaker shall be equipped with controlled switching device with consequent optimization of switching behavior, when used in:

1. Switching of transformer (from 400kV side circuit breakers only)
2. Switching of shunt reactor

6.8.2. The CSD shall be provided in 400kV Circuit breakers for controlling transformers and reactors (ie for breakers of switchable line reactor and in Main& Tie circuit breakers of Transformers, Transmission lines with non-switchable line reactors and Bus reactors). The requirement of CSD shall be explicitly specified in price schedule

6.8.3. Technical Requirement for Controlled switching device:

a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified below.

b) The CSD shall meet the requirements of IEC-61000-4 16 class IV regarding HF disturbance test and fast transient test shall be as per IEC-61000 – 4-4 level IV and insulation test as per 60255 – 5.

c) The CSD shall have functions for switching ON & OFF the circuit breakers.

d) The CSD shall get command to operate the breakers manually or through auto re- close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

e) The CSD shall have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of net operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5 ms.

f) The CSD shall have communication port to facilitate online communication of the control switching device with SCADA directly on 61850 or through gateway which shall be under present scope.

g) The CSD shall be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.

h) The CSD shall be suitable for current input of 1 amp from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The controller shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.

i) The CSD shall have time setting resolution of 0.1 ms or better.

j) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

k) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

l) The provision for bypassing the Controlled switching device shall be provided through BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit Breaker. Alternatively, in case of any non-operation of the CSD after

receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.
m) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

1.1. Tests:

6.10.1. Type Tests:

i. In accordance with the requirements stipulated under Section GTR the circuit breakeralong with its operating mechanism shall conform to the type tests as per IEC-62271-100.

ii. The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted forapproval

iii. Circuit breakers meant for controlled switching shall conform to requirements of IEC/TR-62271–302. The contractor shall submit test reports to demonstrate that the offered CB conforms to the requirements of performance verification tests and parameter definition tests as per IEC/TR 62271-302. The contractor shall also furnishthe report for the re-ignition free arcing window for switching 3-phase shunt reactor as demonstrated in the shunt reactor switching test.

Note:
CSD is not required for the subject project. Hence, TTR for the same shall not applicable.

Application of reactor switching is not envisaged in this project. Hence, the subject clause is not applicable.
However, in case required, the test reports with breaking current in line with IEC 62271-110, clause 4.4.6 table 8 shall be submitted by us in the event of order.

6.10.2. Routine Tests:

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers.
In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

i. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating **control** voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, short esttime between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be **arranged by the contractor at his** own cost. After, completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to AEGCL.

ii. During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test.

iii. Routine tests on Circuit breakers with Controlled switching device as per IEC/TR62271-302.

iv. Complete station assembly in the factory for testing purpose and dis assembly for shipping are as per the shipping units considering transport restrictions.

7. DISCONNECTORS (ISOLATORS)

7.1. Disconnectors shall be three-pole group operated or Single-pole individual operated (as persingle line diagram of the substation) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC- 62271-102 and shall have the ratings as specified in BPS.

7.2. Construction & Design.

7.2.1. The disconnectors shallbe operated by electricmotor suitable for use on DC system and shall be equipped with amanual operating mechanism for emergency use. The motor shall be protected against overcurrent and shortcircuit.

7.2.2. Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all three test duties vizTD1, TD2 and TD3 as per Annexure–F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between busbars in accordance with Annexure–B of IEC:62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

7.2.3. The disconnect switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

7.2.4. It shall be possible to operate the disconnect switches manually by cranks or handwheels.

7.2.5. Formotor-operated disconnect switches, the control should be electrically and/or mechanically uncoupled from the drives haft when the switch is operated manually top revent coincident power operation of the switch and the drive mechanism(s).

7.2.6. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brack ets and grounding devices. All the bearings shall be permanently lubricated or shall be of sucha type that no lubrication or maintenance is required.

7.2.7. The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operationshall be by meansof a two-position control switch located in the Local Control Cabinet (LCC).

7.2.8. Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.

7.2.9. The disconnector operations shall be inter-locked electrically withtheassociatedcircuitbreakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

7.2.10. Each disconnector shall be supplied with auxiliary switch having additional 8 NO (Normally Open) and 8 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired upto the local control cabinet.

7.2.11. The signaling of the closed positionof the disconnector shallnottakeplace unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withsand current can be carried safely.

7.2.12. The signaling of the open position of the disconnecto shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is atleast 80 percent of the rated isolating distance.

7.2.13. The disconnectors and safety grounding switches shall have mechanical/electricalinter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three-phase group. Master key is not permitted.

7.2.14. The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with the remote/local transfer switch set to local.

7.2.15. All electrical sequence interlocks will apply in both remote and local control modes.

7.2.16. Each disconnector shall have aclearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under:

	INSCRIPTION	COLOUR
Openposition	OPEN	GREEN
Closedposition	CLOSED	RED

7.2.17. All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

7.2.18. The disconnecting switches shall be provided with rating plates and shall be easily accessible.

7.2.19. The mechanical endurance class shall be M2 as per IECfor 400kV 220 kV and 132kV disconnectors. Electrical endurance class of the disconnector shall be as per IEC.

7.2.20. Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) and SAS.

7.2.21. Manual operation facility shall be provided for each disconnector in the GIS.

7.2.22. The degree of protection for the DM box of disconector shall be IP42.

8. SAFETY GROUNDING SWITCHES

8.1. Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation). It shall be operated by DC electricmotor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and shortcircuit.

8.2. Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such thatit can only be closed if both the circuit breakerand disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.

8.3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator to gether with position indicator on the Local Control Cabinet (LCC)and provision for taking the signal to Control room.

8.4. The details of the inscription and colouring for the indicator are given as under:

	INSCRIPTION	COLOUR
Openposition	OPEN	GREEN
Closedposition	CLOSED	RED

8.5. Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device willd is able the electrical control circuits.

8.6. Each ground switch shall be fitted withauxiliary switches having 6 NO (Normally Open) and 6 NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.

8.7. Provision shall be made for pad locking / suitable locking arrangement for the ground switches in either the open or closed position.

8.8. All portions of the grounding switch and operating mechanism required for grounding shall be connected to gether utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq.mm.

8.9. The main grounding connections on each grounding switch shall be rated to carry the fullshort circuit current for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

8.10. The safety grounding switches shall conform to the requirements of IEC-62271-102 and shall have electrical endurance class: E0 & shall have mechanical endurance class M2 for400 kV&M1 for220/132 kV voltage level.

8.11. The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for grounds hunt leads.

8.12. Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.

8.13. Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC)/SAS.

8.14. Manual operation facility shall be provided for the earth switches.

8.15. The degree of protection of the DM box of maintenance earth switch shall be IP 42.

9. HIGHSPEED MAKE PROOF GROUNDING SWITCHES:

9.1. Grounding switches located at the beginning of the line feeder bay modules shall be of thehigh speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall confirm to class B and electrical endurance class E1 as perannexure– C ofIEC :62271-102

9.2. High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.

9.3. The switches shall be fitted with a stored energy closing system to provide fault making capacity.

9.4. The short circuit making current rating of each ground switch shall be atleast equal to its peak withstand current rating as specified. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

9.5. Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.

9.6. The details of the inscription and colouring for the indicator shall be as under: -

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

9.7. High speed ground switch operation should be possible locally from Local Control Cabinet (LCC)

9.8. These high-speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

9.9. Each high-speed ground switch shall be fitted with auxiliary switches having additional 6 NO (Normally Open) and6 NC (Normally Closed) contacts for use by others, over and abovethese required for local interlocking and position indication. All contacts shall be wired toterminal blocks in the Local Control Cabinet. Provision shall be made for padlocking theground switches in their open or closed position.

9.10. All portion of the grounding switches and operating mechanism required for connection to ground shall be connected to gether utilizing copper conductor having minimum cross-sectional area of 100 sq.mm.

9.11. The main grounding connection on each grounding switch shall be rated to carry the peakwithstand current rating of the switch for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

9.12. The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

9.13. The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.

10. INSTRUMENT TRANSFORMERS

10.1. Current Transformers

The current transformers and accessories shall conform to IEC: 61869 and other relevant standards except to the extent explicitly modified in the specification.

10.1.1. **Ratios and Characteristics: The** CT core distribution for various voltage levels shall be asper Table 3A, 3B, 3C 3D & 3E. Further the numbers of cores, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with above table attached at Annexure-3.

Where multi-ratio current transformers are required, the various ratios shall be obtained by changing the effectivenumber of turns on the secondary winding.

10.1.2. **Rating and Diagram Plates:** Rating and diagram plates shall be as specified in the IECspecification incorporating the year of manufacture. The rated current & extended current rating incase of current transformers and rated voltage, voltage factor & intermediate voltage incase of voltage transformers shall be clearly indicated on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals(P1&P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

10.1.3. **Constructional Details**:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal-enclosed type.

b) Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous forall cores.

d) The rated extended currents for 800kV and 420kV class Current transformers shall be as given below:

TapRatio	**800kV,3000A**	**400kV,3000 A**

	Rated extended currents in % of rated current	
500/1	**200**	**200**
1000/ 1	**---**	**---**
2000/ 1	**180**	**180**
3000/ 1	**120(200for15min)**	**120**

e) The secondary winding shall be rated for 2A continuously.

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

g) For 800/420/245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over arange of 5% to 120% (or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

h) For 800kV CTs, the instrument security factor at all ratios shall be less than ten (10) for metering core. For 420/245/145kV CTs, the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the LCC panel suitably wired-up to the terminal blocks.

i) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.

j) The current transformers shall be suitable for high-speed auto-reclosing.

k) Provisions shall be made for primary injection testing either within CT or outside.

l) All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency transients typically1-30MHz.

10.2. VOLTAGE TRANSFORMERS

The voltage transformers shall conform to IEC-61869 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminalbox.

10.2.1. **Ratios and Characteristics**: The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be inaccordance with Annexure 4 & Table 4A.

10.2.2. **Rating and diagramplates**: Rating and diagram plate shall be provided complying with the requirements of the IEC specification in corporating the year of manufacture and including turnsratio, voltageratio, burden, connection diagram etc.

10.2.3. Secondary Terminals, Earthing

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of theSF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

10.2.4. The transformer shall be able to sustain full line to line voltage with out saturation of transformer.

10.2.5. Constructional Details of Voltage Transformers:

a) The voltage transformers shall be located as aseparate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to thecapacitanceoftheGIS.

c) The voltage transformers shall have three secondarywindings.

d) Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

e) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

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

g) The diagram for the interconnection of the VTs shall be provided inside secondary terminal box.

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

10.3. Tests:

10.3.1. In accordance with the requirements in Section-GTR, Current Transformer and VoltageTransformer should have been type tested and shall be subjected to routine tests in accordance with relevant IEC.

The type test Report (In English Language only) of the GIS shall be of one of the Internationally Accredited Laboratories only:

(a) KEMA (Holland), (b) CESI (Italy), (c) CERDA (France), (d) PHELA, (Germany), (e) KERI (S. Korea), (f) CPRI/ERDA (India), (g) Intertek (ASTA), UK, (h) ESEF ASEFA, France, (i) JSTC, Japan, (j) SATS Norway, (k) VEIKI, Hungary, (m) FGH (Germany), (n) VOLTA (France), (o) STLNA, USA.

The Routine Test of the GIS equipment shall be performed from NABL accredited laboratory

10.3.2. The test reports of type tests, as applicable, as per IEC-61869-2 for CT, and IEC-61869-3 for IVT and following additional tests shall be submitted for the Employer's review. The type tests for which the procedure is under consideration as per above said IEC is not required to be considered.

a) Current Transformers (CT): Transmitted over voltage test for 145kV and above voltage rating

b) Inductive Voltage Transformers (IVT): Transmitted over voltage test for145kV and above voltage rating

11. SURGE ARRESTORS

11.1. The surge arrestors shall confirm in general to latest IEC–60099-4.

11.2. **Insulation co-ordination and selection of surge arrestor**: The contractor shall be fullyresponsible for complete insulation co-ordination of switchyard including GIS. Contractorshall carry out detailed studies and design calculations to evolve the required parameterslocations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram isindicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer.

The contractor shall perform all necessary studies and the report shall detail the limits of allequipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

11.3. Duty requirements of GIS Surge Arrestor

11.3.1. The surge arrestor shall be SF6 gas insulated metal oxide and gapless type. The metal housing of the arrestor shall be connected to the metal enclosure of the GIS with flange, bolted and gasketedjoint so that the arrestor housing is grounded through GIS enclosure.

11.3.2. Surge arrestor shall be disconnect-link type and be attached to the gas-insulated system in such amanner that they canbe readily disconnected from the system while the system is being dielectrically tested.

11.3.3. The surge arrester shall be of heavy-duty station class and gapless (Metaloxide) type without anyseries or shuntgaps.

11.3.4. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and longlines.

11.3.5. Surgev arresters for the 765kV network shall be capable of discharging of severere-energisation switching surges on a 765kV line with surge impedance of 27 0hms and capacitance of 13 nF/Km.

765kV class arrester shall be capable of discharging energy equivalent to class 5 of IEC for a 765 kV system on two successive operations followed immediately by 50HZ energisation with a sequential voltage profile as specified below:

1000kVp for 3 peaks

910kVp for 0.1Sec.

885kVp for 1Sec.

866kVp for 10Secs.

11.3.6. Surge arresters for the 400kV network shall be capable of discharging of severe re-energisation switching surges on a 400 kV, 450 Km long line with surge impedance of 300ohms and capacitance of 12nF/Km and overvoltage factor of 2.3p.u at the arrest or terminals.

400kV class arrester shall be capable of discharging energy equivalent to class4 of IEC for a 400 kV system on two successive operations followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

650kVp for 3peaks

575kVp for 0.1Sec.

550kVp for 1Sec.

475kVp for 10Secs.

11.3.7. 245&145kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245kV & 145kV system respectively on two successive operations.

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

11.3.9. The surge arresters are being provided to protect the following whose insulation levels are indicated in the table given below: -

Equipment to beprotected	765kVsystem		400kVsystem		220KV system	132KV system
	Lightningimpulse(kVp)	Switchingsurge (kVp)	Lightning impulse (kVp)	Switchingsurge(kVp)	Lightningimpulse (kVp)	Lightningimpulse (kVp)
Power Transformer	±1950	±1550	±1300	±1050	±950	±550
Instrument Transformer	±2100	±1550	±1425	±1050	±1050	±650
Reactor	±1950	±1550	±1300	±1050	-	-

CB/Isolator Phasetoground	±2100	±1550	±1425	±1050	±1050	±650
CB/Isolator Across opencontacts	± 1300(-/+457)	± 1200(-/+653)	± 1425(-/+240)	± 900(-/+345)	±1200	±750

11.3.10. Constructional Features

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

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

11.4. Tests

11.4.1. In accordance with the requirements stipulated, the surge arrestors shall conform type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

11.4.2. Each metaloxide block shall be tested for the guaranteed specific energy capability inaddition tothe routine/acceptance test as per IEC-60099.

11.4.3. Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests withone 100A and 10kA current impulse, (8/20microsec.) shall also be performed on the surge monitor.

11.5. Technical Parameters: Technical parameters are as per Annexure5.

12. OUTDOOR SF6/Air BUSHINGS:

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTP.

The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC-60137.

12.1. Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency with stand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 31mm/Kv.

12.2. Bushing types and fitting: The details of bushing shall be as follows

SF6 to air Bushing shall be of Polymer/composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC:60137. All details of the bushing shall be submitted for approval and design review.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicon e composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462.

12.3. Mechanical forces on bushing terminals: Outdoor bushings must be capable of withstanding cantilever forces due to weight of busduct (GIB) on one side & AIS conductor/Al tube on the otherside and short circuit forces.

12.4. Type test reports as per applicable IEC including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in section GTR for approval.

12.5. The technical parameters of Bushing are as per **GTP.**

13. GIS TO CABLE TERMINATION (Ifapplicable)

13.1. This scope covers the supply, erection, commissioning of connection assembly of fluid-filled or extruded cables to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-209

13.2. The XLPE cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure.

13.3. The GIS to XLPE cable termination shall conform to IEC-62271-209.

13.4. The rating of XLPE cables for different voltages shall be as per BoQ.

13.5. The limits of supply of gas-insulated metal-enclosed switchgear and the cable termination shall be in accordance with IEC62271-209.

13.6. Cable termination and cable connection enclosure shall be suitable for the requirements forwhich it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

13.7. The SF6 cable end unit and connection support structure should be equipped with provisions for isolating the cable sheath or pipe to permit cathodic protection of cable system. (See IEC 62271-209)

13.8. The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to with stand the switchgear high voltage site tests. The contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

13.9. All supporting structures for the SF6 bus-duct connections between the XLPE cable sealingends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the Employer.

13.10. The opening for access shall be provided in each phase terminal enclosures as necessary topermit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

14. TRANSFORMER/REACTOR TERMINATION

14.1. TRANSFORMER/REACTOR Direct Connection with GIS (if applicable)

14.1.1. The scope covers the supply, erection and commissioning of connection assembly of Oil filled Transformer to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-211.

14.1.2. The limits of supply of gas-insulated metal-enclosed switchgear and the direct connection to oil filled transformer shall be in accordance with IEC 62271-211.

14.1.3. The transformer / reactor termination module enables a direct transition from the SF6 gasinsulation to the bushing of anoil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgears or transformer's/reactor's foundations are absorbed by the expansion fitting.

14.1.4. Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's approvaland for co-ordination with transformer and reactor supplier. Any modification suggested by transformer and reactor supplier shall have to be carried out by the GIS supplier to facilitate proper connection with the bushings of the transformer and reactors.

14.2. TRANSFORMER/REACTOR Connection with SF6/AirBushing

14.2.1. The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respectiveTransformer/Reactor supplier and the same shall be connected to the SF6 ducts through air to SF6 bushings to be provided under present scope.

14.3. In case of single-phase Transformers/Reactors are being installed in the substation, HV & IV auxiliary bus for the Transformer/Reactor bank for connecting spare unit shall be formed inside the GIS hall as per the SLD furnished and as specified in Section project.

15. LOCAL CONTROL CUBICLE(LCC)

15.1. Functions

15.1.1. Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore/indicating lamp for status indication of the circuit-breaker and all associated isolators and earthswitches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously.

15.1.2. Status indications in the LCC shall be semaphore type or LED type.

15.1.3. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditionsonly. The emergency trip push buttons shall be properly shrouded.

15.1.4. If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

15.1.5. 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc.

15.1.6. Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. Inplug in connector type cable arrangement, min 2 cores of the cable with connected conditionon both side upto the TB to be left unused as spare.

15.1.7. Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earthswitches shall be located in a separate cubicle compartment.

15.1.8. LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS

15.2. Constructional features

15.2.1. Local Control Cubicle shall either be free standing, floor mounting type (Standalone) or Bay Mounted (Integrated) type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight be a ring member of the panels such as base frame, front sheet and door frames, and 2.0 mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to providelevel transportation and installation. Alternatively folded sheet panels of adequate thicknessand strength is alsoacceptable.

15.2.2. Access to all compartments shall be provided by doors. All fastenings shall be integral withthe panel or door and provision made for locking. Cubicles shall be well ventilated throughvermin-proof louvers (if required) having anti insect screen. All doors shall be gasketed allaround with suitably profiled Neoprene/EPDM gaskets conforming tothe provision of IS11149. However, XLPE gaskets can also be used for fixing protective glass doors.

15.2.3. For LCC panel of each feeder bay (i.e. line, transformer, and reactor etc.), Bus Coupler bayand Bus Sectionalizer bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB / DCDB.Thecontrol DC supply (for control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loopin Loopout AC Supply can be provided.

15.2.4. Each panel shall be provided with necessary arrangements for receiving, distributing andisolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS:13703 mounted on plug-in type fuse bases. The shorttime fuse rating of Fuses shall be not less than 9KA.Fuse carrier bases hall have imprints of the fuse'rating 'and' voltage'.

15.2.5. EachLCCPanelshallbeprovidedwiththefollowing

1. **Plug Point**: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15Amps pin round standard Indian plug, shall be provided in the interior of each cubiclewith ON-OFFswitch.
2. **Interior Lighting**: Each panel shall be provided with a door-operated LED lightingfixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination ofthepanelcontrolledbythe respective paneldoor switch.
3. **Space Heater**: Each panel shall be provided with a thermostatically connected spaceheater rated for 240V, single phase, 50 Hz AC supply for the internal heating of thepanel to prevent condensation of moisture. The fittings shall be complete with switchunit.

15.2.6. Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.

15.2.7. The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the controlswitches shall be internal i.e. installedbehinda lockableglassdoor, that allowsa complete view of theannunciator andmimic diagram when theLCCdoor is closed. Necessary protection shall be provided to avoid inadvertent operation ofcontrolswitches.

15.2.8. An interlocking scheme shall be provided that takes in to account the following basic requirements.

- To safe guard maintenance personnel who may be working on one section of the equipment with other section slive.
- Prevent in correct switching sequences that could lead to a hazardous situation toplant, equipmentand personnel.

15.2.9. Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

15.2.10. Where key interlocking is employed tripping of the circuit breaker shall not occur if anyattempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.

15.2.11. Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one busbar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

15.2.12. Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.

15.2.13. All isolating devices shall be interlocked with associated circuit-breakers and isolators inthe same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.

15.3. Cabling between LCC Panel and GIS equipment

15.3.1. The unarmored screen cable shall be of 1.1kV grade, multicore, annealed copper conductor, Tinned copper braided screen (approx. 85% coverage).

15.3.2. The core insulation and outer sheath of cable shall be of halogen-free special polymer.

15.3.3. The cable shall be flame-retardant, flexible, abrasion-and wear-resistant.

15.3.4. The size of core shall not be less than 2.5sq. mm for instrument transformers and 1.5 sq. mm for other control cable.

15.3.5. Pre fabricated cables with heavy duty multi-pointplug-inconnections on GIS end shall be provided.

15.3.6. All instrument transformer connections shall be hardwired to terminal block via ring type connection.

16. GIS BUILDING

16.1. The buildings shall house each voltage class Gas Insulated Switchgear (GIS) and other associated equipment inside each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per project requirement including space for future bays.

16.2. For finalizing the dimensions of GIS building the requirement of Turning radius to rotate the largest removable component for assembly/disassembly shall be taken in to consideration.

16.3. Wherever GIS Building of already exists, then the existing GIS Building(s) for respective voltage class shall be suitably extended keeping the width of the building same to accommodate the number of bays/diameters as specified in the Project.

16.4. The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.

16.5. The area for GIS Building(s) is indicated in the tender document. The area given is for reference only and may vary according to the requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

16.6. The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, Communication panels etc. in a separate Relay Panel Room in the GIS building. The size of the room shall be such that all the panels for thebays/ diameters shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers.

17. ELECTRIC OVERHEAD CRANE:

One EOT Crane each for GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection

& maintenance of GIS equipment. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component crane.

The Crane shall be used for the erection and maintenance of the GIS switchgear component and all plant installed in the GIS switchgear room. On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the plant area.

The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.

The crane shall have minimum speeds under full load of:

Speed

Hoisting 2 meters/minute

Cross Travel 16 meters/minute Long Travel 20 meters/minute

Creep speed shall be of25% of operating speed

The electric overhead cranes shall be provided with walkways, platforms. Guard hand rails shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul. An access platform shall be provided together with a guarded ladder on the crane to allow access to the bridge rails.

The crane shall be possible to be operated through the cable, through the pendant control and which shall be easily accessible from the floor of GIS building and through remote control device. Manufacturer/contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of 5.

The crane for 132kV GIS shall have capacity of minimum 7.5T safe working load & minimum height of crane have shall be 8.0 meters or as per actual requirement whichever is higher. In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders to facilitate movement of EOT crane in the extended portion of GIS hall.

The following tests should be performed for EOT Crane:

The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.

Further the following tests may be done at site after installation of the crane at site a. Check althea accessories for proper function.

The following tests may be EOT Crane

The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.

Further the following tests may be done at site after installation of the crane at site

a. Check all the accessories for proper function

b. No load test

c. Load test as per site conditions.

Constructional details

The double web, box construction crane bridge girders shall be in one piece or in pieces suitable for transportation if in pieces the design of multi piece construction shall require the approval of the Engineer in Charge. Cross travel rails shall be fixed to the bridge girders by clamping only and not welding. Plates, bars, angle sections and where practicable other rolled sections, used in the load bearing members of structures shall be not less than 6 mm thickness. The end

Carriages shall be of double web plate box construction or I section connected to the girders by welding at top or by large gusset plates and fitted bolts to ensure maximum rigidity. Drop stops and jacking pads shall be built-in features. Full length plate form of checker plate of minimum thickness 6 mm shall be provided along both sides of the crane to ensure easy, safe excess to the crane crab, travel gears and other parts. Safety railing shall be provided on crane bridges and crab frame. Foot-walk shall have sufficient width to give 500 mm minimum clear passage at all points, except between railing and bridge drive where this clearance may be reduced to not less than 400mm.

EOT Crane shall be double girder.

Rope Drums

Rope drums shall be of cast steel or fabricated from seamless tubes, conforming to the relevant Indian Standards. Fabricated rope drums shall be stress relieved before any machining takes place. The sizing of drum shall conform to IS 3177 Clause 5.

Rope Sheaves

Rope sheaves shall be of cast steel or fabricated from rolled steel plates, conforming to Clause 6 of IS 3177.

Wire Ropes

The wires shall be hemp cored for all cranes. Ropes shall be of regular right hand lay as per IS 2266. The rope construction shall be 6 x 37 up to 16 mm diameter and 6 x 36 above 16 mm diameter, with a factor of safety specified as per Clause 5.6.1 of IS 3177.

Hook Block

The sheaves shall be fully encased in close fitting guards fabricated from steel plate. Smooth opening shall be provided in the guards to allow for free movement of the rope. Holes shall be provided for oil drainage.

Lifting Hooks

The lifting hook shall be one that will best suit this type of crane and as per IS 3177. Hooks shall be quality tested by a third-party agency such as SGS or Lloyds.

Gears and Gear Boxes

Straight and helical spur gearing shall be used for all motions. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and shall be of tempered alloy steel having metric module. Overhung gears shall not be used. The design and general arrangement of gear boxes shall be as per Clause 10 of IS 3177. All gearing shall be totally enclosed/immersed in oil.

Track Wheels

Crab/Crane wheels shall be double flanged. Wheels shall be mounted in anti-friction roller bearings housed in “L” shaped bearing brackets for ease of removal during routine maintenance. Flangeless wheels with guide rollers would also be acceptable. Solid wheels shall be of forged/rolled steel or cast steel. In general, the track wheels shall conform to Clause 11 of IS 3177.

Rails

The rails shall be specified as being suitable for the crane duty used no square bars will be acceptable. The rails shall be complete with end stops, holding down bolts and taper washers and shall be suitable for connection to the station earth. Access to the crane for maintenance purposes from the walking plate form by means of a steel ladder with cage shall be provided. The crane shall be provided with full length walkway on drive side girder and small walkway on another girder. Walkway shall be at least 500 mm clear inside.

Couplings

All couplings shall be of steel or cast iron of grade 260 conforming to IS 210 and shall be designed to suit the maximum torque that may be developed. The manual drive shaft and hoist drum shall be connected to the gear box input shaft through a flexible shock absorbing coupling as per Clause 8 of IS 3177.

Bearing and Bearing Housing

Anti-friction bearing housings shall be used throughout, except where required otherwise for technical reasons, conforming to Clause 7 of IS 3177.

Shafts

All shafts shall be made of steel as per Clause 9 of IS 3177.

Electrical details

The general technical details for the electrical systems specified elsewhere in the document will apply to the electrical equipment for the gantry crane also. The following points deal with the special requirements for the crane. In case of any contradiction with the electrical specifications described elsewhere in this document, the special requirements detailed hereafter shall have precedence.

415 V, 3 Phase, 4 wire electric power supply will be available at one point for the crane bus. The Tenderer shall provide a metal enclosed switch box housing a 63 A TPN switch, CT operated ammeter and voltmeter, with selector switch. This switch box shall be located approx. 1.2 meters above the floor level. The incoming cable must be of suitable size aluminum conductor, PVC insulated, PVC sheathed, strip armoured. From this switch onwards, the Tenderer shall arrange and terminate the supply at the crane bus.

Crane Power Supply

415 Volts +/- 10%, 3 Phase, 4 Wire, 50 Hz +/- 5%, AC through trolley lines. Current Collector

Two No. per trolley line shall be provided; each rated for 100% of total crane rating. Double collectors on each earth trolley shall be provided and these shall be different from those on the power trolley line. Collector rollers and shoes shall be designed to reduce sparking to the minimum level possible Power Distribution on Crane. An off/load manual isolator, with a locking facility shall be provided immediately after the current collectors on the incoming line on the crane.

Power from the isolator shall be taken to the circuit breaker located in protective panel of the crane. The breaker shall be provided with under voltage, overload and short circuit release or relays. The breaker can only be closed when:

All controllers are in neutral position;

None of the stator or directional contactors are in closed position; Door/gate switches are not actuated;

Rotary and gravity limit switches for hoist motion not operated.

Power Supply for Lighting and Magnet Circuits

Power for lighting and magnet circuits shall be tapped from the incoming side of isolator near current collectors.

Power Supply for Cross traverse Motion

A flexible traveling crane system mounted on a retracting support system shall be used. The conductor shall consist of insulated multi-conductor or several single conductor cables with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. The clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cables. The flexible copper cables shall be of butyl rubber or EPR insulated CSP sheathed type 650/1100 V Grade.

Panels

All panels shall be of free-standing floor mounted construction, suitable to withstand any vibrations emanating from the crane. The panel and its components shall conform to standards of Electrical Technical Specifications for LT Switchgear/Panel, described elsewhere in this document.

Motors

Heavy duty motors suitable for crane operation, shall be reversible, suitable for frequent acceleration and mechanical breaking, totally enclosed, fan cooled, wound rotor type. The duty of the motor shall be S5, as per IS 325. Class of insulation shall be "B". The pull-out torque is to be not less than 225% of full load torque, corresponding to 40% CDF (Cycle Duration Factor of the motor). The main motor shall have the speed ranges suitable for gearbox and operating speed for a Class 2 crane.

Brakes

Brakes shall be provided for hoisting motions. Brakes shall be thruster type. Brakes shall be designed to be fail-safe whenever there is a current interruption, either intentionally or by main power supply failure. The capacity of brakes, brake drums, shoes and brake adjustment shall be as per Clause 14.4 of IS 3177.

Limit Switches

Only drum limit switches are acceptable. Roller operated, resetting limit switches shall be provided for all motors. For each hoist motion, a rotary type over-winding self-resetting limit switch shall be provided. An indication shall be provided to the operator whenever this limit switch has been operated. Limit switches shall be fitted to prevent over travelling and over traversing and any other special requirements.

Resistance

Resistances shall be air-cooled, robust, heavy duty, corrosion resistant, punched stainless steel grid type/cast iron grid resistor. Suitable tapping points shall be provided. Resistance boxes shall be mounted in racks that permit independent travel of any selected box.

Pendent Controller

1. Pendent push button station shall comprise of the following and be suitable for 110 V AC:
2. Key operated ON push button-standard green button.
3. on signal lamp-green lens.
4. Emergency OFF push button-standard red button.
5. Hoisting push button- standard black button.
6. Lowering push button-standard yellow button.
7. Micro Hoisting push button- standard black button.
8. Micro Lowering push button- standard black button.
9. Cross traverse forward push button- standard black button.
10. Cross traverse reverse push button- standard black button.
11. Micro Cross traverse forward push button- standard black button.
12. Micro Cross traverse reverse push button- standard black button.
13. Long traverse forward push button- standard black button.
14. Long traverse reverse push button- standard black button.
15. Micro Long traverse forward push button- standard black button.
16. Micro Long traverse reverse push button- standard black button.
17. Crane light ON/OFF push button.
18. Bell ON/OFF push button

18. SEISMIC DESIGN CRITERIA:

18.1. The equipment shall be designed for operation in seismic zone V for earthquake resistance. These is micload sare due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC62271-207 for the design of equipment. The equipment along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. Test Report/Analysis Report should be furnished.

19. DESIGN REVIEW

19.1. Design reviews shall be conducted by Employer; however, the entire responsibility of designshall bewith thesupplier.

19.2. Employer may also visit to the supplier's works to inspect design, manufacturing and test facilities.

19.3. The design review will commence after placement of award with the successful contractor and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer reserve the right to waive off the design review during detailed engineering.

19.4. The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGREreportNo. 125 prepared by CIGRE Working Group23.10.

19.5. The manufacturer will be required to demonstrate the use of adequate safety margins forthermal, mechanical, dielectric, insulation coordination and vibration etc. design to take intothe account the uncertain ties of his design and manufacturing processes.

19.6. The scope of such a design review shall at least include the following:

1.	Dielectric Stress of Solid Insulation like Gas Barrier, support insulatoretc.
2.	Dielectric stress of SF6 Gas Volume.
3.	Mechanical strength of enclosure, expansion joints etc.
4.	Criteria for providing expansion joint.
5.	Sealing system
6.	Insulation coordination
7.	Thermal stress and resulting increasing as pressure during short circuit condition.
8.	Earthing of enclosure w.r.t circulating current.
9.	Seismic design, as per IEC 62271-207
10.	Circuit Breaker.
11.	Isolator and Earth switch.
12.	Voltage transformer.
13.	Current Transformer.
14.	Surge Arrester.
15.	Bushing.
16.	Ducting.
17.	Corrosion protection.
18.	Electrical and physical Interfaces with substation.
19.	Testing capabilities.
20.	Inspection and test plan.
21.	Transport and storage.
22.	Maintain ability.
23.	Site Test.

19.7. Further, the manufacturer shall furnish the following information during detailed engineering:

a) Study report of VFTO generated for GIS installation for 400kV and above.

b) Calculation for adequacy of UHF sensors to be provided in GIS Installation

c) The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure.

d) Calculations to show that there is no Ferroresonance due to capacitance of GIS for the voltage transformers.

e) Calculations in support of touch & step voltages in all enclosures and earthing of complete GIS installation.

f) Measures to mitigate transient enclosure voltage by high frequency currents.

g) The acceptance criteria and limits of impact (of impact recorder) in all three directions which can be with stood by the equipment during transportation and handling.

20. TYPE TESTS

The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

Sl.	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on Auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and Measurement of the resistance of the main circuit
3	Tests to prove the ability of the main and earthing circuits to carry the rated Peak and rated short time withstand current
4	Tests to verify the making and breaking capacity of the included switching Devices
5	Tests to prove the satisfactory operation of the included switching devices
6	Tests to prove the strength of the enclosures
7	Gas tightness tests
8	Tests on partitions
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on Insulators
13	Additional tests on auxiliary and control circuits
14	Reactor current switching test For Reactive Current switching capability as per Clause6.4.1
15	Test to demonstrate the Power frequency with stand capability of breaker in open Condition at lockout pressure.
16	Electromagnetic compatibility tests(ifapplicable)
17	Radio inference voltage tests

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnect Switch, Grounding switches, Currentand Voltage transformers as per relevantIEC and type tests of SF6/Air & Oilbushing as per IEC 60137 shall be submitted for approval as per Section-GTR, Technical Specification.

21. MISCELLANEOUS

21.1. **Painting of enclosure**: All enclosures shall be painted externally as per manufacturer's painting procedure.

21.2. **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensation inside various Marshaling boxes.

21.3. Identification & rating plate

Each bay shall have a name plate showing

a) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnect Switch Grounding switches, Current transformer, Voltage transformers, Surge arrester etc shall be as per the irrelevant IEC.

b) A schematic diagram indicating the irrelative locations.

22. TRANSPORT OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and off loading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of **impact recorders** (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. In case of electronic impact recorder, the recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

23. PACKING, STORAGE AND UNPACKING

23.1. All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

23.2. The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

23.3. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport andhandling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

23.4. Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

23.5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping.Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that,allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.

23.6. Blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site which may on later stage necessarily be used during repair and maintenance shall remain the property of AEGCL. Balance blanking plates, caps, seals, etc shall be returnable to the contractor. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O'rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

23.7. Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also becapped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

23.8. For bus ducts involving male and female joints of the current carrying conductor, the sameshall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected.

23.9. The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing on raised platform, as required etc. is included inthe works to be performed by the contractor. **Cost of the raised platform for temporary storage is deemed to be included in overall cost.** The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge.

23.10. The equipment shall be unpacked immediately before Installation. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum.

When ever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen or SF6 gas until required.

23.11. For the purpose of release of payment linked to receipt and physical verification in case ofGIS equipment it shall mean random opening and physical verification of one number of packing unit of each type of main equipment (i.e., GIS CB/ISO/ES/PT/LA etc.) for each voltage level. There after properre-packing of the GIS unit shall be ensured as per manufacturer recommendation.

24. INSTALLATION OF GIS

24.1. Civil works of GIS Hall shall be completed in all respects before taking up the installationand it shall be ensured that Ventilation System is operational and all dust and dirt in the hall are removed. The GIS Hall needs to be in positive pressure before starting Installation.

24.2. The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall undertake the erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate toAEGCL.

24.3. Un-packaging of GIS modules shall be done outside the GIS hall and in no case module to be taken inside GIS hall with packing.

24.4. **All assembly work shallbe done by qualified personnel only who are to be identified and list submitted to AEGCL site before starting of erection work.**

24.5. Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of erection work.

24.6. Working personnel shallclean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non-fluffy material.

24.7. **GIS hall door shall have automatic close facility after entry of personnel to avoid dust and moisture entry**. Walls and ceiling shall be in a condition so that neither dirt nor plaster mightfall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.

24.8. Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done on regular basis.

24.9. Only T&P and consumables required for GIS erection shall be kept in GIS

during erection.

24.10. In case of outdoor installation of GIS or of GIS components open gas, compartments shall beprotected from dust and moisture ingress (by tarpaulin covers/protective enclosure/chamberetc)

24.11. Bus duct exits in the GIS hall's wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.

24.12. Maintenance room (as a part of LCR room) shall be constructed for carrying out repair works/ small part assembly. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in this room for rework.

24.13. Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved by AEGCL site before start of erection. Shock recorder down loaded data and analysis shall be submitted preferably before commencement of erection work. In case of violation of shock limits, expert form manufacturer shall visit and do the joint internal inspection and shall submit analysis report before giving clearance for erection. If required the module shall be taken back to factory for further analysis and testing.

24.14. Cleaning is of utmost importance and hence before assembly, all theloose metal parts, subassemblies and all contact & sealing surfaces shall be cleaned before installation. Cleaning shall be carried out with specified cleaning agents of the manufacturer, in no condition water is to be used except for external surfaces. Further, prior to opening of gas compartment, the same shall be thoroughly cleaned externally. The vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected.

24.15. All Civil Work inside building including internal cable trench shall be completed before GIS installation.

24.16. Installation of flanges shall be done immediately after removal of transport covers. Transport covers, O-rings and other packing material of GIS shall be taken out immediately after removal.

24.17. O-Rings shall be properly stored and taken out only before installation. O-Rings are also to be cleaned before use with manufacturer authorized cleaning agent.

24.18. At all points of time during installation authorized personnel shall use suitable gloves to avoid contamination.

24.19. Cable termination work shall commence only after completion of GIS equipment erection, as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.

24.20. Approved Field Quality Plan shall be followed during site work.

25. ON SITE TESTING

After the GIS Switchgear has been fully installed at site and SF6 gas filled at rated fillingdensity, the complete assembly shall be subjected to the site tests as per IEC-62271-203 Methodstatement/procedure of ONSITE high voltage testing, PD measurement and Switching Impulse test shall be submitted by contractor inadvance.

(A) Commissioning Tests/On Site Tests After Erection:

After erection, and before putting into service, the gas-insulated metal enclosed Switchgear shall be tested for the correct operation and dielectric strength of the equipment.

These tests and verifications shall comprise:

(1) Tests to be conducted on the circuit breaker at site at all required operating sequences Measurement of operating time

Checking of wiring and connections and dielectric checks Indications, alarms and interlocks, auxiliary contacts

Operation at minimum and maximum control supply voltage/pressure Operation of anti-pumping device.

(2) Test to be conducted on the Disconnectors at site Checking of wiring and connections and dielectric checks Indications, alarms and interlocks, auxiliary contacts

Operation at minimum and maximum control supply voltage/pressure

(3) Other Tests at Site

Dielectric tests on auxiliary circuits

Measurement of the resistance of the main circuit Measurement of gas condition
Gas tightness tests General verifications
Tests as per IEEE C37.122.1 clause 4.10.5 Demonstration of operational compatibility with SCADA
Mechanical operation tests of circuit breakers, Disconnectors and earthing switches and high-speed earthing switches Insulation resistance measurement

(B) Power Frequency Test: On Site Testing of GIS

Power frequency tests for the completed GIS at site shall be complied as per IEC 60270.
Power frequency tests for the completed GIS at site shall be possible without removing the voltage transformers. The power frequency test voltage at site shall be 80% of the factory test voltage for 1 min at 100Hz.
The Supplier is responsible to furnish the test equipment for conducting following performance tests at site. Voltage tests on main circuits at reduced voltage (80% p.f.) comprising:

- 50 Hz A.C. voltage test for 1 min
- Partial Discharge test the manufacturer shall provide:

-The test voltage source.
-All connections between the switchgear and the test voltage source.
The procedure to be implemented following a discharge during dielectric tests is as follows:

- if a disruptive discharge occurs at the first test while increasing of test voltage, a second test is performed.
- If a second disruptive discharge occurs in the same compartment before reaching the highest level, there are two possibilities:

- If the second disruptive discharge is higher than the first voltage again the voltage is immediately increased. If a new discharge occurs the value of which is again higher, a new test will be carried out.
- If the second disruptive discharge is lower than or equal to the first, the test is stopped and the compartment dismantled.

The process is continued in order to reach the test voltage. If a disruptive discharge occurs at this voltage, there are two possibilities:

- if it is the first disruptive discharge in the compartment since the test was begun, voltage is again increased. If there is no other discharge, the test has been successful. The test is stopped and the compartment dismantled.
- if some discharge has previously occurred in this compartment during the increase in voltage, the test is stopped and the compartment dismantled.

Required test equipment
During the on-site tests, the supplier shall provide all necessary test facilities and equipment (such as high voltage test kit) for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc.

26. MANDATORY SPARE

(Note: There are no mandatory spares for the GIS Modules in the scope of this tender.)

Design, engineering, manufacture, testing, supply on FOR destination site basis including transportation & insurance, storage at site of Mandatory spares for the GIS. Standard list of Mandatory Spares is as per Chapter

Safety:

To ensure safety of personnel during maintenance, the GIS and switch room shall be arranged to facilitate safe and direct personnel access to all locations as follows:

1. Electrical and mechanical points of control of the GIS (disconnectors, earthing switches and circuit breaker mechanical trip mechanism)
2. Mechanical position indication of circuit breakers
3. Mechanical position indicators of disconnectors and earth switches
4. Inspection windows to verify position of disconnectors and earth switches
5. Gas density monitors, pressure transducers and filling points
6. Circuit breaker spring status mechanical indication
7. Current transformer secondary connection terminal boxes
8. Voltage transformer secondary connection terminal boxes

Where the layout consists of two or more bays coupled to each other via the busbar, the busbar shall incorporate an additional buffer or spacer compartment to allow movement of personnel in between the bays to access any components located to the side of bays to carry out the activities 1 to 8 as listed above.

The additional buffer compartment shall be provided where the proposed equipment does not provide an access route between the bays. The buffer or spacer compartment shall be suitably sized such that a minimum of 1000 mm width spacing is provided between bays to allow access and movement of persons carrying out operations, regular inspection and maintenance tasks. Where the Customer proposes to supply free standing LCC's, the cabinets shall be free standing positioned over a cable ope or floor opening to accept the low voltage control cabling. The cabinet shall be swing frame type with door opening outwards to the left-hand side. All points of control shall be located on the front of the cabinet to allow operation and inspection without stepping inside the cabinet. The interior of the cabinet shall be equipped with a light. Removable gland plates shall be labelled with permanent stickers identifying the Safe Working Load (SWL) that the plate may bear. Adequate safety screens shall be provided for all moving parts. Provision shall be made for carrying out primary injection tests on all current and voltage transformers without requiring internal access to any gas compartment. The HV cable screen termination box in the HV cable room should be accessible from ground level.

TESTING & MAINTENACE EQUIPMENT

Special Tools

Any special tools needed for installation, operation and inspection shall be included in the quotation.
These special tools shall be supplied along with the GIS and shall not be taken back by the Tenderer. For gas handling purpose following tools shall be quoted as a minimum:

a) SF6 Gas Processing, Drying, Storage & Filling Unit
b) Online Partial Discharge Monitoring Unit
c) SF6 gas quality testing unit SF6 Gas Leak Detector
d) Precision Pressure Gauge
e) SF6 Gas Evacuation Plant (One mobile cart and one static cart)

f) Video Borescope

Testing & Maintenance equipment shall be offered, as per BoQ.

26.1. SF6 Gas leakage detector.

The detector shall be portable, battery-operated, hand-held type and having a minimum SF6gas leakage sensitivity of 5gm/year. The sensor shallbe connected through a flexible wandfor easy accessibility to joints, seals and couplings in GIS equipment and provided with aprotection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication. The equipment shall have automaticzeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The testkitshallbecompatiblefor EMI/EMC environment as per IEC1000.

26.2. Gas filling and evacuating plant:(Gas Processing unit)

- The plant necessary for filling and evacuating the SF6 gas in the switch gear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of thetemporary storage facilities shall atleast be sufficient for storing the maximum quantity ofgas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).
- Where any item of the filling and evacuating plant is of such a weight that it cannot easily becarried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.
- The minimum capacity parameters of evacuation plant will beas under: Oil Free Suction (Recovery) Pump: 30M^3/Hour
  Compressor (TwoStage): 15M^3/Hour
  Oil Free Vacuum Pump: 100M^3/Hour
- The evacuation equipment shall be provided with all the necessary pipes, couplings flexible tubes and valves for coupling up to the switch gear for filling or evacuating all the gases.

  Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished

26.3. SF6 gas analyzer:

The SF6 gas analyser should be of portable type and instruments shall have following features:

a. In-built calibration facility.
b. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.
c. Equipment shall work on zero gas loss principle i.e.; gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.
d. Equipment shall be supplied with suitable regulator which can be used to connect

SF6 cylinder if required.

e. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376

i) SF6 purity–Range:0-100% & Accuracy: +/-2 deg

ii) Dewpoint- Range: - 60 to +20 deg C& Accuracy: +/-4 deg C

iii) SO2-Range:0-150ppm & Accuracy: +/-2%

iv) HF-Range:0-10ppm & Accuracy: +/-10%

f. Instrument should work on AC source as well as on rechargeable battery

g. Input pressure: upto10 bar

h. It should be housed in a robust IP67 case with wheels

26.4. Online Partial Discharge Monitoring System

- GIS equipment shall be designed so as to minimize partial discharge or other electricaldischarge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.
- An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.
- On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths forbest measurement results. The principle of operation shall be based on UHF principle of detection.
- The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble-free online PD monitoring of complete GIS installation shall be considered as included in the scope.

The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHFPD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.

The integration of UHFPD coupler in future GIS bays shall be done in respective package. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).

The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Work station PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive(1TB), Ethernet port 100 Mbps, printer. The work station PC shall be powered by suitable dedicated UPS and same is included in the present scope.

- Design of on-line PDM System

1. The technical proposal for PDM system along with detailed design documentation shall be submitted for EMPLOYER'S approval during engineering stage.
2. To guarantee that sufficient coverage is available for complete GIS installation tomonitor PD activity all design details shall be submitted as part of the above for review.
3. The sensitivity of the offered system shall be in accordance with CIGRE Document No.654 thatwillbe verified as part of site sensitivity tests.
4. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
5. The signal attenuation level of co-axial cable permeter length and justification for the length of cable connection between the couplers and detector units shall be furnished.
6. The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.
7. TheSub-station GIS layout as a separate drawing indicating positionof spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc. shall be submitted during engineering stage for approval.
8. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labelling and indicated in the substation PDMSLD.
9. Internal arrangement/wiring diagram is to be submitted for detector units/control cabinet etc. All internal items are to be identified/labelled to facilitate troubleshooting.
10. Supply requirement (AC&DC) to be specified for the complete monitoring system.
11. Power supply to PDM PC shall have protection against surges, overload and shortcircuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. Ratings of UPS shall be proposed for the approval of EMPLOYER'S. The UPS shall have enough capacity to initiate a 'safe'shut down of the PDM PC and the peripherals after this 15-minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication/alarm when it requires battery replacement. Potential Free Contacts shall be generated to signal these events. These contacts shallbe wired out to Annunciation / Monitoring systems. Alternately, inverter of suitable capacity is also acceptable. Critical Process and Status alarms of the PDM system shall be displayed.

12. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave patternwhenever any PD activity detected by

the system. System shall be able to give online3D point on wave pattern, online PRPD (phase resolved PD) and online short timetrend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.

13. Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS should be furnished.
14. The selected mode of propagation of PD signal(electromagneticwave) inside GIS for the design of sensors shall be furnished.
15. The protection available for electronics against transient overvoltages caused by switching operations shall be furnished.
16. The capacity of each detector unitto be specified to accommodate as many numbers of PD sensors signal.
17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation must be submitted in this regard.
18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.

- **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as tests pecimen during the coupler calibration. The pulse injection level determined through above factory calibration testsshall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

- **Every Day Use & Maintenance**: The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is not iced or the system itself is in failure, there by eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

- **Computers and Peripherals:** The PC operating system shall be the latest version of MS Windows/LINUX. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type subject to EMPLOYER'S/Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard discand retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LCD type of reputed make.

- **Filtering Facility:** The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noisefrom real PD. The exposed gas barriers of the GIS shall be shielded effectively againstnoise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as anoption) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall bespecified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.

- **Self-Test (Diagnostic) Facility**: Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger analarm for communication to SAS.
- **External check facility:** Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.
- **Detector Units**: The sensitivity of each detector unit shall be furnished. The sensitivity levelof individual detector units shall be selectable depending on the site background noiselevel.
- **Trend Plot**: The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.
- **PD Monitoring modes**: There shall be two different mode sof system operation viz. adedicated Continuous PD Monitoring mode for the normal day today operation of the system & adedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature.

  In the HV Commissioningmode the real time display shall be possible for a minimum of two complete bays with associated busbars and at with ones econd update period. The HV test software shall automatically record the HV voltage information along with PD soas to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.
- **Alarm Facility:** The PDM system shall generate alarm when action is required; viz. a) PDalarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to beconnected toSAS.
- **Real Time Display:** The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second-update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.
- **Schematics: The** PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.

- **Print Option/Facility:** PDM system should have the option/facility of printing all trendplots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for thispurposeat substation.

- **Data Archives:** This is to provide access to historical data and files to rage with date and time stamp. Sufficient storage facility shall be available to review historical data updatedfor the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.

- **PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance**

  Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built-in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patters as library pictures to train the user.

  Software Updates: It shall be possible to upgrade / update the system software through out the life time of the system with the ongoing development / refinement in PD technology.

- Fault investigation: In case of any indication of suspected PD activity by the on-line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period

- Special Tools/equipment, Spare Parts, software packages

  Special Tools: Special tools for cutting and crimping of coaxial cable with 'NConnectors' shall be supplied.

  Spare parts: The contractorhas tosupply critical spares with replacement procedure for the trouble-free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.

  Software Packages: The complete software package shall be supplied as part of a back-upfacility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.

  Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

- Operation & Maintenance Manual: A complete O&M manual covering all aspects of troubleshooting of PDM system in six sets in original shall be provided & also in CD's. For diagram references colour pictures shall be provided. As tep-by-step procedure for spare parts replacement shall also be included.

- **Factory / Site Test Formats**: The factory & site tests format to be submitted for approval. Theformat shall cover all possible tests to confirm healthiness of the system and to record the testvalues.

- List of References: The bidder shall provide a reference list of PD monitoring system, which is supplied by the mandin successful operation worldwide in a powerutility.

Video Borescope:

- LCD: 16.25 cm (6.4 in) diagonal active-matrix VGA color LCD
- Display Resolution: 640 x 480px
- Sunlight Readable: 1100 Cd/Msquared
- Mounting: 75 x 75 mm (1/4-20) and vesa mount
- Battery Life (continuous): 6 to 8hrs (integrated), 3600 mAh rechargeable battery
- Frame Rate: 30fps (NTSC & PAL)
- Video / Image Transfer: SD Card or USB
- Camera Diameter Range: 25mm
- Camera Focal Length Options: Long View and Short View Macro
- Camera Length Range: 30m
- Video resolution: 960x480 (avi format) (with sound)
- Image Resolution: 640x480 (jpeg format)
- Memory: Internal 4GB, 16 GB SD card (expandable to 32 GB)
- Transmission frequency: 2.4GHz
- Transmission Range: 32ft (10m) unobstructed view
- Viewing direction: Viewing angle 110 degree
- Power: AC: 90-264 Vac, 47-63HZ, <1.2 A rms @90Vac
- DC: 10.2V +5/-3%. 4.9A
- Tip Operating Temp: -25°C to 100°C (-13°F to 212°F) Reduced articulation below 0°C(32°F)
- System Operating Temp: -20°C to 46°C (-4°F to 115°F)
- Storage Temperature: -25°C to 60°C (-13°F to 140°F)
- Relative Humidity: 95% max, non-condensing
- Waterproof: Insertion tube and tip to 14.7 psi (1 bar, 10.2m of H_2O, 33.5 ft of H_2O)
- Ingress Protection: IP67
- Joystick Control: 360° All-Way® tip articulation, bump gesture, menu access and navigation
- Button Set: Access user functions, measurement and digital functions
- Audio: Integrated 2.5mm headset/microphone jack
- Data I/O Ports: Two USB 2.0 ports
- Brightness Control: Auto and Variable

- Illumination Type: White LED
- Long Exposure: Via auto and manual mode
- White Balance: Factory default or user defined
- Operating System: Real-time multi-tasking operating system
- User Interface: Simple drop-down menu-driven operation Menu navigation using articulation joystick
- File Manager: Embedded file manager software supporting: File & Folder creation, naming, deleting, Store to internal Flash (C:\) or USB Thumb Drive Copy between USB and C:\
- MDI Software (optional): Provides user defined guided inspection, Creates DICONDE compatible inspection

  files, Creates MS Word™ compatible inspection reports
- Audio Data: PC compatible (.mp3) file format
- Image Control: Invert, Zoom (5X digital) Image Capture and Recall
- Digital Zoom: Continuous (5.0X)
- Image Formats: Bitmap (.BMP), JPEG (.JPG)
- Video Format: AVI
- Text Annotation: Built-in full screen text overlay generator, 100 text line capacity

- Graphic Annotation: User placement of arrows
- Articulation Control: "Steer & Stay" articulation lock/fine articulation
- Tip "Home" return to neutral forward-tip orientation
- User-selectable fine or coarse control XpertSteer probe articulation offers quick steering responsiveness for tight probe control bump steering enables slight adjustments to probe position
- Software Updates: Field updateable via USB Thumb Drive
- Languages: English
- Boost function improved image quality in dark environments
- Illumination: 12 white LEDs

TRAINING:

(Training should be provided by successful bidder. No price implication will be borne by AEGCL.)

The successful bidder shall organize a 15 (official) days training program at GIS manufacturer's end for 10 numbers of AEGCL engineers at free of cost making understand all the key points related to the design of GIS and shall also highlight the maintenance issues related to GIS and steps to tackle them. The GIS manufacturer shall provide a detailed training to the AEGCL engineers. Further, the successful bidder shall organize an on-site GIS training program also for 10 (official) days for 20 AEGCL engineers at free of cost where the GIS manufacturer will provide necessary training for on-site testing and all other key points related to GIS erection, operation and maintenance.

The successful bidder shall also organize an on-site training program for 7 (official) days for 20 numbers of AEGCL engineers at free of cost for GIS handling and maintenance equipment for familiarizing the handling equipments with the AEGCL engineers. The manufacturer of each GIS maintenance equipment (as mentioned in the BoQ) shall provide necessary training regarding operation and maintenance of the gas handling and other equipments

GENERAL TECHNICAL PARAMETERS FOR GIS

Sl. No.	Parameter Names	Gas Room	Category	Unit	Value
1	Rated voltage			kV	145
2	Rated frequency			Hz	50/60
3	Rated current			A	3150
4	Rated short circuit breaking current			kA	40
5	Rated short time withstand current			kA	40
6	Rated duration of short circuit			s	4
7	Rated peak withstand current (virtual value)			kA	100/104
8	Rated power frequency withstand voltage (1 min)		Earthing	kV	275
			Breaking	kV	275+84
9	Rated lightening impulse withstand (peak)		Earthing	kV	650
			Breaking	kV	650+118
10	SF6 Gas Pressure (20°C)	Circuit Breaker Compartment	Rated Pressure	Mpa	0.58
			Alarm Pressure	Mpa	0.53
			Lockout Pressure	Mpa	0.5
		Other Compartments	Rated Pressure	Mpa	0.58
			First Alarm	Mpa	0.53
			Second Alarm	Mpa	0.5
11	Part discharge (80% of the power frequency withstand voltage)		The Whole Bay	pC	5
			Insulation	pC	3
12	Rated short circuit current making time (FES)			time	2
13	Mechanical Endurance		Circuit Breaker	Time	10000
			DES/FES	time	10000
14	Gas Room Moisture content of the SF6 gas	Circuit Breaker Compartment	Value of the transfer	μL/L	≤150
			Running	μL/L	≤300
		Other Compartment	Value of the transfer	μL/L	≤250
			Running	μL/L	≤500
15	SF6 gas leakage rate in years				≤0.5%

SYSTEM PARAMETERS (132kV GIS)	AS PER OPERATED RATING
Nominal Current (Bus bar/Bus Coupler)	3150 A
Nominal Current (Transformer/Feeder Bay)	3150 A
System Voltage	132kV
Rated Voltage	145kV
Rated Short Circuit Current(kA/s)	40kA/4s
Rated Making Current	100kA
Rated Power Frequency Withstand Voltage	275kV
Rated Lightning Impulse Withstand Voltage	650kV
Internal arc withstand time	300ms
Maximum gas loss per year	<0.5%

145 KV GIS COMPONENTS PARAMETERS:		
		AS PER EXISTING RATING
MBUS	145kV 2000A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA
CB-52	145kV 2000A/1250A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA
DES-89E/89A	145kV 2000A/1250A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA
DS-89	145kV 2000A/1250A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA
ES-89E	145kV 31.5kA/1S 80kA	145kV 40kA/4S 100kA
FES-89E	145kV 31.5kA/1S 80kA	145kV 40kA/4S 100kA
CT	145kV 2000A/800A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA
BSG	145kV 1250A 31.5kA/1S 80kA	145kV 3150A 40kA/4S 100kA

The technical paramaters and ratings of each module shall be as per the existing paramaters of the 132kV GIS at Amingaon Site. The drawings and documents of the existing GIS at Amingaon GSS have been uploaded with the Tender Documents.

SF6 CIRCUIT-BREAKER PARAMETERS:	
Standard code IEC 62271-100	
Rated voltage 145 kV	Rated short circuit breaking current 40kA
Rated current 3150 A	Rated short circuit making current 100 kA
Rated frequency 50 Hz	Rated short-time withstand current(4s) 40kA
Rated gas pressure (20 C) 0.58MPa	Rated peak withstand current 100kA
Alarm/closure gas pressure 0.53/0.50Mpa	Rated line-charging breaking current 160 A
Rated operating sequence O-0.3s-CO-180s-CO	Rated lightning impulse withstand voltage 650 kV
	Rated power-frequency withstand voltage(1min) 275kV

SECTION – 11

Technical Specifications for Copper Control and Power Cable

This technical specification intends to cover the following:

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

2. Technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), 6.35/11 kV (Uo/U) Voltage Grade, 3-Core, 185 Sq. mm Stranded Compacted Circular Shaped Aluminium Conductor of H4 Grade, shielded with extruded Semi-conducting compound, XLPE insulated, PVC sheathed, GI Round wire armoured Power and Control Cables for effectively grounded system. The cable shall confirm to the latest revisions of IS: 7098 (Part –2). For cable list refer Table-1 (Sl. no. 2.0).

Note:

1. Tenders will only be considered from the cable manufacturers and any one supplier to whom manufacturer can authorize. The bidder shall have adequate experience of at least 5 years in manufacturing of LT/MV & HT cables.
2. Copper samples from the finished cable drums shall be tested at any 3rd party NABL accredited lab to ensure its purity.
3. The following document shall be attached with technical part of the bid:

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

   ii. Deviation sheet, if any

Table 1

Sl. no	Power Cable
1	3C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
2	4C X 2.5 Sq.mm, Copper Power Cable Type: 2XWY
3	3C X 4 Sq.mm, Copper Power Cable Type: 2XWY
4	4C X 4 Sq.mm, Copper Power Cable Type: 2XWY
5	3C X 6 Sq.mm, Copper

	Power Cable Type: 2XWY
6	4C X 16 Sq.mm, Copper Power Cable Type: 2XWY
7	3C X 10 Sq.mm, Copper Power Cable Type: 2XWY
8	4C X 10 Sq.mm, Copper Power Cable Type: 2XWY
9	3C X 16 Sq.mm, Copper Power Cable Type: 2XWY
10	2C X 16 sqmm
11	2CX50 sqmm
12	3.5 C X 35 sqmm
13	3.5 CX70 sqmm
14	3.5 C X 95 sqmm
15	3.5 C X 150 sqmm
16	3.5 C X 300 sqmm
17	1 C X 1000 sqmm
18	2C X 6 sqmm
Control Cable	
1	2 C, 1.5mmsq
2	4C, 2.5 sq mm
3	5C, 2.5 sq mm
4	7C, 1.5 sq mm
5	7C, 2.5 sq mm
6	10 C, 2.5 sq mm
7	12 C, 2.5 sq mm
8	12 C,1.5 sq mm
9	14 C, 2.5 sqmm
10	17 C,1.5 sqmm
11	19 C,1.5 sqmm
12	19C,2.5 sqmm

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

1. STANDARDS

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

a.	IS-7098, 1998 (Part-I)	:	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto 1100V.
b.	IS-3961	:	Recommended current ratings for Cables
c.	IS 8130-1984	:	Specification for conductors for insulated electric cables and flexible cords.
d.	IS-3975, 1999	:	Low Carbon galvanized steel wires, formed wires & tapes for armouring of cables
e.	IS-4759	:	Specifications for Hot dipped galvanized coating on round steel Wires
f.	IS-5831	:	PVC insulation and sheath of electric cables.
g.	IS-10418	:	Drums for electric cables.
h.	IS-10810	:	Method of test for cables.

2. SERVICE CONDITION

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

3. DESIGN AND CONSTRUCTION PERTICULARS

3.1. General

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

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

3.2. Technical parameters

i.	Quantity	:	Refer Table-1
ii.	Packaging	:	Steel drum packaging, each having single length cable ≥

			500 metres.
iii.	Cable Type	:	A2XWY/ 2XWY (refer Table-1 for details)
iv.	No. of Cores	:	Shall be decided during detailed engineering (Cable sizing calculation)
v.	Voltage Level	:	1.1Kv
vi.	System Grounding	:	Solidly Grounded

vii. Nominal System voltage : 400V ±10%

viii. Nominal System Frequency: 50 Hz

ix. Maximum conductor temperature at rated current: 90 deg C

x. Maximum conductor temperature at Short-circuit: 250 deg C

xi. Conductor Conductor Material: H4-Grade Aluminium of purity > 99.6% Electrolytic grade Copper, Purity > 99.97%

xii. Conductor type: Stranded with number of strands as per IS 8130 (Part-I) 1984

xiii. Insulating material: Cross-Linked-Polyethylene (XLPE) Compound.

xiv. Core Identification Strips: Red, Yellow, Blue & Black (for neutral)

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

3.3. Conductor

COPPER

The conductors shall be made from high conductivity copper rods complying with IS: 613-1964. The conductor material used shall be electrolytic grade with high purity. *Two sample conductors randomly selected from finished lot of cables, shall be tested for its purity at any 3rd party NABL accredited lab.*

Cable Joints:

Joints shall be permitted in the individual wires of which the conductor is formed, but no joint shall be within 300 mm of any other joint within the same layer. The joints shall be made by resistance butt welding, fusion welding, cold pressure welding, electric welding, gas welding, brazing or silver soldering. No joint is allowed in the conductor after stranding. A maximum of two joint shall be allowed in any strand forming complete length of the cable.

The conductors shall conform to appropriate dimensions, resistance and number of wires in the conductor (number of strands) as given in IS 8130 (Part I): 1984.

3.4. Insulation

The insulating material for power and control cables shall be extruded cross linked polyethylene (XLPE) compound as per IS-7098(Part-I)-1988. The minimum thickness of insulation shall not be less than the values specified in Table-2 of IS-7098 (Part-I)-1988. No negative tolerance shall be applicable for the thickness. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions. The cores shall be identified as per the following colour scheme:

3-Core - Red, Yellow & Blue

3 ½ or 4-Core - Red, Yellow, Blue & Black

3.5. Inner Sheath

The inner sheath shall be extruded FRLS PVC, Type ST2, compatible with thermal rating of insulation conforming to IS-6380-1984. The sheath shall have adequate thickness, mechanical strength and elasticity, as specified in IS 5831. The material shall be soft thermoplastic type, applied by extrusion method. The thickness of the inner sheath shall be as per IS: 7098 (Part I) and the color of the inner sheath shall be Grey. The inner sheath shall be so formed that it fits closely on the laid-up cores and could be easily removed without damaging insulation. One or more layer of proofed plastic tape shall be provided over the laid-up core before extrusion.

3.6. Armouring

The armouring arranged over the inner sheath shall consist of one layer of galvanized round steel wires for all sizes of cable. The armour round wire used on the cable shall conform to IS: 3975 for all requirements. The direction of lay of armour shall be opposite to that of the cores. The zinc coating on the galvanized steel strip shall comply with relevant standards.

The joints in armour wires/strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire/strip shall be at least 300 mm away from the nearest joint in any other wire/strip in the completed cable.

3.7. Outer Sheath

Extruded outer sheath shall be provided over the armouring. The material used for sheathing shall be FRLS PVC sheath, Type ST-2 base compound conforming to IS 1554/ IS 5831 for power and control cable. The outer sheath shall be so formed that it fits closely on the laid up armour and could be easily removed without damaging the intermediate sheath and insulation. The colour of the outer sheath shall be black. The thickness of outer sheath shall be in accordance with the IS 1554 (Part-I)-1988. Suitable additives shall be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment.

Cables shall have suitable fillers laid up with the conductor to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the temperature of the cable and compatible with the insulating material. The material shall be of the best quality and workmanship. The fillers and sheath material shall be non-hygroscopic. All materials shall be new, unused and of the finest quality.

4. TESTS

All the tests specified below shall be carried out in accordance with the Indian Standards by the manufacturer in the presence of Purchaser’s representative. If the cable fails to pass the test specified, the Purchaser shall have the option to reject it. Shipping release shall be obtained from the Purchaser's representative. The Purchaser, however reserves the right to waive off the inspection.

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards, in addition any test called for by the Purchaser or his representative to ensure that the equipment being supplied fulfils the requirement of the specification.

For test not covered by any code or specifically mentioned in this specification, the test procedures are to be agreed with the Purchaser.

Pre-Dispatch Inspection

The manufacturer shall be given at least 15 days advance notice prior to the commencement of testing, so that Purchaser's representative can plan to witness the tests.

All the tests indicated in the test clause of this specification shall be carried out in the presence of Purchaser's representative by the manufacturer and shall provide all the facilities and equipment for testing.

Six copies of the Test Certificate shall be furnished to the Purchaser for approval prior to dispatch of cables from factory.

Visual check to conform the details given in this specification is to be done. In addition to the above, the general workmanship of the cable drums and cables laid in drums shall be checked.

Manufacturer shall have proper test set up for testing all the routine tests & type tests on finished cables as per IEC.

List of type tests mentioned in the tender specifications shall be conducted on four drum irrespective of type test certificates given or not.

4.1. **Type Test**

Type tests on four randomly selected cable drums will have to be conducted in the presence of the department's representative. The test samples will be taken from finished cables. This test shall be in accordance to IS: 7098, Part-1,1988.

a. Test on Conductor

- Annealing test for copper conductors
- Tensile test for aluminium conductor
- Wrapping test for aluminium conductor
- Conductor Resistance Test

b. Test on Insulation

- Physical dimension measurement
- Tensile strength and elongation at break
- Hot set test
- Shrinkage test
- Ageing in air oven
- Water absorption test

c. Test on round Armour

- Physical dimension measurement
- Tensile strength
- Elongation at break
- Torsion test for round wires
- Winding test for firmed wire
- Mass of zinc coating.
- Uniformity of zinc coating

- Resistivity measurement, Resistance test for armour

d. Test on Sheath

- Physical dimension measurement
- Tensile strength & Elongation at break test
- Ageing in air oven
- Loss of mass in air oven
- Shrinkage test
- Hot deformation test
- Heat shock test
- Thermal stability test

e. Insulation Resistance Test

f. High Voltage Test at room temperature

g. Volume resistivity at room temperature & at 90° C. (IS-10810-Part 43)

h. Flammability test

i. *Test requirement of FRLS inner and outer sheath*

The inner and outer sheath of cables shall meet the following test requirements related to flame retardant, low smoke emission, low acid and toxic gas emission. The BIDDERs shall have proper test apparatus to conduct all the relevant tests as per the applicable standards:

- Flame retardant test on single cable.
- Oxygen Index Test

  The critical oxygen index value shall be minimum 29 when tested at 27+2ºC as per ASTMD-2863

- Temperature index test

  Temperature index value shall be minimum 250ºC at oxygen index of 21 when tested as per NES 715.

- Flammability test

- Smoke Density Test

  The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

- Acid Gas Generation test (halogen acid gas evolution)

  The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.

- Test for specific optical density of smoke

- Anti termite and rodent property test

The sequence of electric tests shall be as per the relevant Indian/International standards. The Bidder shall submit the sequence of tests for the approval of the purchaser before conducting the tests. A copy of the adopted standard shall also be supplied.

4.2. Routine Test (On each drum)

The following routine tests shall be carried out by the Manufacturer on each and every length of the cable in the presence of Purchaser's representative at manufacturer's works.

a. Resistance test for conductors
b. Insulation resistance test
c. High voltage test

4.3. Conductor purity test

Two samples of aluminium and copper shall be taken from any of the finished set of cables at random and the sample shall be tested for its purity at a NABL accredited lab.

Qualifying Criteria:

The test results should be within limits as per IS 7098. All the routine tests as per IS 7098 / IEC shall be conducted and passed as per the limits given in the standards. All the bought-out certificates will be verified and the test results shall be as per respective standards.

5. IDENTIFICATION

The following details shall be marked sequentially for each meter run length of the cable by non-erasable embossing on the outer sheath:

a. Reference to Indian Standard
b. Name of the manufacturer/ Trade Name
c. Name of the project:
d. Configuration of the cable: viz. Voltage grade, no. of Core, Sq. mm, A2XWY/2XWY/YWY / YY as applicable
e. Year of manufacturing
f. Sequential marking of running meter length
   The running length of the cable shall be identified at regular intervals of one meter (Increasing order from inner end to outer end of the cable)

6. PACKAGING

- Each drum shall consist of single length cable ≥ 500 metres.
- The cable shall be wound on *non-returnable steel drums* of suitable size, packed and marked.
- Packing shall be sturdy to protect the cable from any injury during transportation, handling and storage. The cut ends of the cable shall be sealed by means of non-hygroscopic sealing material preferably Heat shrinkable end caps.

- One end of the cable shall be brought out of the drum and suitably clamped to the drum flange with proper mechanical protection. Location of the other end may be marked on the drum.
- The cable shall be placed on drums in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. No undue stress shall appear on cables when laid on drums.
- The cable drum shall carry the following information stencilled on a metallic label, securely attached to each end of the drum:

  i. Reference to the Indian standard
  ii. Manufacturer's name, brand or trade mark
  iii. Type of cable and voltage grade
  iv. No. of cores
  v. Nominal cross-sectional area of conductor
  vi. Cable code
  vii. Length of cable on drum
  viii. No. of lengths on reel, drum or coil (if more than one)
  ix. Gross weight
  x. Country of manufacture
  xi. Year of manufacture
  xii. Direction of rotation of drum (an arrow)
  xiii. ISI certification mark

7. PREFERRED MAKE

POLYCAB/KEI/KEC or reputed brand possessing system certification of ISO 9001:2008, ISO14001:2004, OHSAS18001:2007 & EN 16001-2009 and product certifications IS: 7098 (Part-I), CE, UL etc. Quotations without these certification details will not be considered for technical evaluation.

Preferred make of bought out material:

a.	Aluminium for Conductor	:	Hindalco/Balco/Nalco or better
b.	Copper for Conductor	:	Hindustan Copper/Hindalco or better
c.	XLPE compound of Insulator	:	Dow/Borealis or better

8. GUARANTEE

All the cables shall be guaranteed against faulty material, defective design & poor workmanship for a period of 18 months from the date of commissioning. The materials becoming defective during the guarantee period shall be replaced free of cost and the defects arising out of the works shall be rectified free of charge without delay.

ANNEXURE-I

Technical Data Format for 1.1KV, XLPE Insulated, Copper Cable

The tenderer shall furnish all technical details as called for in the following format for all sizes of cables failing which the tender shall be considered as incomplete. *The details shall be furnished separately for all the cables.*

Sl. No.	Particulars	Details
A	Cores	
1	No. of cores	
2	Nom Area of conductor in sq mm.	
3	Voltage Grade	
B	Conductor	
1	Standard Applicable	
2	Material Copper Grade	
3	Purity	
4	Nominal Cross Sectional Area	
5	Form of conductor/circular shaped	
6	No. of strands	
7	Nominal dia of each strand	
8	Temperature co-efficient of resistance at 20 degree celsius	
C	Insulation	
1	Standard Applicable	
2	Material (Mention Type)	
3	XLPE is cured by steam process or Gas process?	
4	Minimum Average Thickness	
5	Tolerance on the smallest of the measured values of thickness of Insulation	
6	Minimum volume resistivity at 27 degcel	
7	Minimum volume resistivity at 70 degcel	
8	Colour Scheme for identification of cores	
9	Average Dielectric Strength	
D	Inner Sheath	
1	Standard Applicable	
2	Material for inner sheath	
3	Minimum thickness of inner sheath	
4	Whether extruded	
E	Armour	
1	Standard Applicable	
2	Shape	
3	Size	
4	Material for Armour	
F	Outer Sheath/Overall Covering	
1	Standard Applicable	
2	Material (type)	
3	Whether extruded	

4	Minimum average thickness	
5	Whether anti-termite treatment has been given in the outer sheath	
6	Whether flame retardant low smoke compound added in the outer sheath	
G	Electrical Properties	
1	Maximum DC Resistance of conductor at 20 deg Celsius in ohms/km	
2	Maximum DC Resistance of amour at 20 deg Celsius in ohms/km	
3	Maximum Permissible conductor temperature	
	Under continuous full load	
	Under transient conditions	
4	Loss Tangent at normal frequency	
5	Reactance at maximum operating temperature 50 Hz (ohm/km)	
6	Capacitance at maximum operating temperature 50 Hz (ohm/km)	
7	Total Impedance at maximum operating temperature 50 Hz (ohm/km)	
8	Recommended continuous current rating	
	In Ground at 30 deg C Ground Temperature (A)	
	In Trench/Ducts at 40 deg C (A)	
	In Air at 40 deg C ambient Temperature (A)	
9	Short Ckt Current Rating for 1 sec duration (in KA)	
	Conductor	
	Armour	
10	Minimum volume Resistivity of insulation	
	At 27 °C in Ohm cm	
	At Max operating temperature in Ohm-cm	
11	Approximate AC resistance at max. Operating temperature	
	Phase	
	Neutral	
H	Mechanical Data	
1	OverallDia of the cable	
2	Dia of the cable under the sheath	
3	Diameter under armour	
4	Diameter over the stranded cores	
5	Wight of cable per km.	
6	Drum length	
7	Tolerance on drum length	
8	Total weight of the drum	
9	Dimension of the drum	
10	Recommended minimum installation radius/ bending radius	
11	Maximum safe pulling force	
12	Whether identification as per clause of the specification is being provided	
13	Whether packing has been done as per clause of the specification	

SECTION - 12

TECHNICAL SPECIFICATION OF ISOLATORS

12.1.0 TECHNICAL PARTICULARS OF 132 kV & 33 KV ISOLATOR

	Type:	**132 kV**	**33 kV**
1	Main switch	Horizontal Centre break	Horizontal Double break
2	Service	Outdoor	
3	Applicable standard	IS : 9921 / IEC-62271-102	
4	No. of Phases	3 phase	
5	Design Ambient temperature	50°C	
6	Type of operation	Mechanically Ganged	
7	Rated voltage (kV)	In KV	In KV
	c) Nominal	132	33
	d) Maximum	145	36
8	Rated current (Amps)	2000	1250
9	Short time current for 3sec.(kA)	40	31.5
10	Rated frequency	50 HZ $\pm$ 5%	
11	System earthing	Effectively earthed	
12	Temperature rise	As per relevant IS/IEC standards	
13	Lightening Impulse withstand voltage (kVp)		
	(a) Across Isolating distance	750	195
	(b) To earth	650	170
14	1-minute power frequency withstand voltage		
	a) Across Isolating distance	315	80
	b) To earth	275	70
15	Switching Impulse withstand voltage (kVp)		
	a) Across Isolating distance	-	-
	b) To earth	-	-
16	Max. RIV for frequency between 0.5MHz and 2MHz (micro-volt)	500 at 92kV	-
17	Corona Extinction Voltage (kV)	-	-
18	Operating mechanism		
	a) Isolator	Motor	Motor
	b) Earth switch	Motor	Manual
19	Auxiliary voltage		
	a) Control & Interlock	220V DC 80% to 110%	

	b) Motor voltage	3 Phase 415V AC 50Hz	
	c) Heater, lamp & socket	Single phase 240 V 50HZ	
20	Safe duration of overload		
	150% of rated current	5 minute	
	120% of rated current	30 minute	
21	Minimum creepage distance of insulator (mm)		
22	Mounting structure	Tubular	Tubular
		/ Lattice	/ Lattice
23	Operating time	Less than 12 secs	
24	Insulator Data		
	a) Bending Strength (kgf)	800	600
	Type:	**132 kV**	**33 kV**
	b) Height (mm)	1500	508
	c) Bottom PCD (mm)	184	76
	d) No. of holes & hole dia.	4x18	4xM12
	e) Top PCD	127	76
	f) No. of holes & hole dia.	4xM16	4xM12
	g) Minimum creepage distance (mm) 25mm/kV	4495	1116
25	Working clearance (live part to ground) (in mm)	4600	3700
26	Phase Spacing (mm.)	3000	1500
27	Minimum clearances (mm.)		
	a) Phase to Phase	1300	320
	b) Phase to earth	1300	320
	c) Sectional clearance	4000	3000

12.2.0 SCOPE

This specification provides for design, manufacturer, testing at manufacturer's Works and delivery, supervision of erection, commissioning (if required) of outdoor station type 132KV/ 33KV, 3 phase triple pole (as mentioned above) Isolator with/ without earth switches, with electrical interlock, insulators and complete in all respect with bimetallic connectors arcing horns operating mechanism, auxiliary switches, indicating devices, fixing detail etc. as described hereinafter.

12.3.0 STANDARDS

Disconnecting switches covered by this specification shall conform to latest edition IEC-129/IEC 62271-102 I.S.1813 and IS: 9921, IS-325 and unless specifically stated otherwise in this specification.

12.4.0 TYPE

The 132 KV Isolators shall be outdoor type with three phase centre break type/Pantograph type as required [Single (SI)/ Double (DI)] Isolators suitable for electrical as well as manual operation and local/ remote operation; but 33KV Isolators (SI or DI) shall be outdoor type with three phase double break center rotating manual as well as motor operated type with local operation. They shall have crank and reduction gear mechanism.

All Isolators offered shall be suitable for horizontal upright mounting on steel structures. Each pole unit of the multiple Isolators shall be of identical construction and mechanically linked for gang operation.

Each pole of the Isolator shall be provided with two sets of contacts to be operated in series and the moving contact blades shall rotate in horizontal plane.

The design shall be such that the operating mechanism with the linkages shall be suitable for mounting on any of the outer pole ends without much difficulty and with minimum shifting of parts.

Moving contacts of all isolators shall rotate through 90 deg. from their “fully closed position” to “fully open position so that the break is distinct and clearly visible from ground level.

The Isolators offered by the Bidder shall be designed for Normal rating current for Isolator as follows:

132kV	33kV
2000A	1250A

It should suitable for continuous service at the system voltages specified herein. The Isolators shall be suitable to carry the rated current continuously and full short circuit current of 40/31.5 KA for 132/33 KV respectively for 3 second at site condition without any appreciable rise in temperature. These shall also be suitable for operation at 110% rated (normal) voltage. The Isolators shall be suitable for Isolating low capacitive / inductive currents of 0.7amp at 0.15 power factor. The isolators shall be so constructed that they don’t open under the influence of short circuit conditions.

The Isolators and earthing switches are required to be used on electrically exposed installation and this should be taken into account while fixing the clearance between phases and between phase and earth.

12.5.0 MAIN CONTACTS

All Isolators shall have heavy duty, self-aligning and high-pressure line type contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper strips of proper thickness and contact area. Fixed contact should consist of loops of above copper strips suitable for 4000 Amps, 3150 Amps, 2000 Amps, and 1250Amps ratings for 400kV, 220 KV, 132KV and 33KV Isolators respectively. The hard dawn electrolytic copper strips should be silver plated 25micron thickness and fixed contacts should be backed by powerful phosphor bronze/stainless steel springs of suitable numbers. The main contacts should be preferably of tulip type design. However, the thickness and contact area of the contact should conform to the drawing approved during type test. Moving contact with moving arm should be of hard-drawn electrolytic copper of proper thickness and contact area.

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current of 63/50/40/31.5 KA for 400/220/132/33KV respectively for 3 seconds without any appreciable rise in temperature. The Isolator blades shall retain their form and straightness under all conditions of operation including all mechanical stress arising out of operation as well as under rated short circuit condition.

Fixed guides shall be provided so that even when the blades are out of alignment by one inch (maximum), closing of the switches, proper seating of the blades in between contacts and adequate pressure to give enough contact surface is ensured. Wherever possible, the blades shall be counter balanced by weights and springs. The contact shall be self-cleaning by the wiping action created by the movements of the blades. The surface of the contacts shall be tendered smooth and silver plated (25 micron).

The Isolator shall be self-cleaning type so that when isolators remain closed for long periods in a heavily polluted atmosphere, binding does not occur. No undue wear or scuffing shall be evident during the mechanical endurance tests, contacts and springs shall be designed so that adjustment of contact pressure shall not be necessary throughout the life of the isolator. Each contact or part of contacts shall be independently sprung so that full pressure is maintained on all contact at all times.

12.6.0 ARCING HORN AND GRADING HORN

Suitable arcing horn made of tinned electrolytic copper which are required for guiding contacts shall be provided on the fixed and moving contacts of all Isolators. The contacts shall be of ‘make before and break after” type.

12.7.0 ELECTRICAL INTERLOCK / MECHANICAL INTERLOCK

The disconnecting switches whenever required shall be with an approved type electrical interlock for interlocking with the associated circuit breakers and earth switch. Electrical interlock assembly should be more right in construction and properly mounted to ensure reliable operation. The design should be such that the electrical circuit for the interlocking mechanism will only remain energised during operation of the switches.

12.8.0 AUXILIARY SWITCHES

All isolators and earthing switches shall be provided with 220VDC auxiliary switches for their remote position indication on the control board and for electrical locking with other equipment. The auxiliary switch shall be provided with a minimum of six auxiliary contacts- 10 normally open and 10 normally closed and 10 normally open and 10 normally closed for earth switch. Separate auxiliary switches shall be provided for isolating and earth switches. 6 additional NO and NC contact to be provided as spare in each case.

The auxiliary switches and auxiliary circuits shall have a continuous current carrying capacity of at least 10 Amps. Auxiliary switches shall not be used as limit switches. Details of make, rating and type of limit switch shall be furnished in the offer.

12.9.0 EARTH SWITCH

Line earth switch shall consist of three earthing blades for Isolator which normally rest against the frame when the connected Isolator is in closed position. The earthing blades for three phases shall be mechanically linked to a coupling shaft which shall be capable of being fitted on either side of the Isolator. The earthing blades shall match and be similar to the main switch blades and shall be provided at the hinge; with suitable flexible conductors with terminal lugs for connecting to the station ground bus. The earthing blades shall be operated by a separate mechanism but shall be mechanically interlocked with the main switch so that the earthing blades can be closed only when the main switches are in open position and vice-versa. The earthing blades shall be gang operated and all the three blades will operate simultaneously.

12.10.0 OPERATING MACHANISM

The operating mechanism shall be simple and shall ensure quick and effective 1000 operation. The design shall be such as to enable one man to operate it with nominal effort. The operating mechanism box shall be made out of aluminum extruded (Aluminum alloy) sections of minimum 3.0 mm thickness. The operating mechanism shall be strong rigid and not subject to rebound.

The Isolator blades shall be in positive continuous control throughout the entire cycles of operation. The operating rods and pipes shall be rigid enough to maintain positive control under most adverse conditions and to withstand all torsional and bending stresses arising from operation. Operation of the switches at any speed should not result in improper functioning, in displacement of parts / machines after final adjustment has been made. All holes in cranks, linkages etc. having moving pins shall be drilled and fitted accurately so as to prevent slackness and lost motion.

Provision shall be made for padlocking the operating mechanism of disconnecting and earth switches in both open and closed positions.

Bearings shall be ball and roller type shall be protected from weather and dust by means of cover and grease retainers. Bearings pressures shall be kept low to ensure long life and care of operation.

Each power operated isolator shall be motor driven as well as manually operated and shall be complete with local / remote selector switch and open / close push buttons. The function of all control facilitates operating isolators.

Provision shall be made in the control cabinet to disconnect power supply to prevent local / remote power operation. Limit switches for open and close positions of re-isolations and earth switches.

All the terminal blocks to be used in the operating mechanism should of stud type of Polyamide/Mealmine material of make like Elmex (OAT-6 for non disconnecting type & OAT –6T for disconnecting type) / connectwell (Equivalent).

12.11.0 DESIGN, MATERIALS AND WORKMANSHIP

The live parts shall be designed to eliminate sharp points, edges and similar corona producing surfaces. Where this is impracticable, adequate shields to be provided. All ferrous metal parts shall be hot dip galvanized, as per IS 2629.All metal parts shall be of such materials or treated in such a way so as to avoid rust, corrosion and deterioration due to continued exposure to atmosphere and rain. All current carrying parts shall be made from high conductivity electrolytic copper / aluminium.

Bolts, screws and pins shall be provided with standard locking device viz. Locknuts, spring washers, keys etc. and when used with current carrying parts, they shall be made of copper silicon or other high conductivity and wear resistant alloys.
The switches should not need lubrication of any parts except at very long interval of five year minimum.

12.12.0 PROTECTIVE COATINGS

All ferrous parts including bolts, nuts and washers of the switches assembly shall be galvanized to withstand at least six one minute dips in copper sulphate solution of requisite strength (Prece tests) except the threaded portions which should withstand four dips.

12.13.0 INSULATORS

Support insulators for all type of isolators shall be of solid core type. The insulator shall be made of homogeneous and vitreous porcelain of high mechanical and dielectric strength. It shall have sufficient mechanical strength to sustain electrical and mechanical loading on account of wind load, short circuit forces etc. Glazing of the porcelains shall be of uniform dark brown color with a smooth surface arranged to shed away raise water. The porcelain shall be free from laminations and other flaws or imperfections that might affect the mechanical or dielectric quality. It shall be thoroughly vitrified, tough and impervious to moisture. The porcelain and metal ports shall be assembled in such a manner and with such material that any thermal differential expansion between the metal and porcelain parts throughout the range of temperature specified in this specification shall not loosen the parts or create under internal stresses which may affect the mechanical or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stresses in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings. The insulator shall be suitable for water washing by rain or artificial means in service condition. Profile of the insulator shall also conform to IEC-815. Insulator shall have a minimum cantilever strength of 800 Kgs (for132KV) & 600 Kgs for (33KV). Caps to be provided on top of the insulator shall be of high-grade cast iron or malleable steel casting. It shall be machine faced and hot dip galvanized. The cap shall have four numbers of tapped holes spaced on a pitch circle diameter of 127mm. The holes shall be suitable for bolts with threads having anti corrosive protection. The effective depth of threads shall not be less than the nominal diameter of the bolt. The cap shall be so designed that it shall be free from visible corona and shall have radio interference level within 500 micro volts. Casing shall be free from blow holes cracks and such other defects.

12.14.0 CONTROL CABINET

The control cabinet of the operating mechanism shall be made out of minimum 3mm thick aluminium alloy sheet. Hinged door shall be provided with pad locking arrangement. Sloping rain hood shall be provided to cover all sides. 15 mm thick neoprene or better type of gaskets shall be provided to ensure degree of protections of at least IP 55 as per IS 2147/IS-3947. The cabinet shall be suitable for mounting on support structure with adjustment for vertical, horizontal and longitudinal alignment.

Details of these arrangements shall be furnished along with the offer.

12.15.0 MOTOR

Motors rated 1 Kw and above shall be suitable for operation on 3 phase, 415 V, 50 HZ supply. Motors of lower rating shall be single phase type suitable for 240V, 50HZ system. It shall be totally enclosed type if mounted outside the control cabinet. The motor shall withstand without damage stalled torque for at least 3 times the time lag of the tripping device. The motor shall, in all other respects, conform to the requirement of I.S. 325.

12.16.0 GEAR

The dis-connector / isolator may be required to operate occasionally, with considerably long idle intervals. Special care shall be taken for selection of material for gear and lubrication of gears to meet this requirement. The gear shall be made out of aluminium bronze or any other better material lubricated for life with graphite or better-quality non-drawing and non-hardening type grease. Wherever necessary automatic relieving mechanism shall be provided suitable relay, Device shall be provided to prevent over loading of the motor. Single phase preventer (for 3 phase meter) shall be provided to operate on open circuiting of any phase and shall trip off the motor. Complete details of the devices shall be furnished in the offer.

12.17.0 SPACE HEATERS

Space heaters suitable for 1 phase 240V AC supply shall be provided for each motor operated operating mechanism to prevent condensation and shall be operated by MCB.

12.18.0 TERMINAL BLOCK AND WIRINGS

Each operating mechanism shall be provided with 1100V grade stud type terminal block. All auxiliary switches, interlocks and other terminals shall be wired up to terminal block. The terminal block shall have at least 20% extra terminals. All wiring shall be carried out with 1.1KV grade insulated 2.5 sq.mm. copper wires.

12.19.0 INTERIOR ILLUMINATION

A holder suitable for a 240 V lamp shall be provided in each of the motor operated mechanism of three poles & shall be door operated type.

12.20.0 CONTROL AND AUXILIARY SUPPLY

A 3-phase switch with MCB for phases and link for neutral, shall be provided for power supply and a 2 pole MCB shall be provided for control supply.

12.21.0 POSITION INDICATOR

A position indicator to show the isolator is in ON or OFF position to be provided.

12.22.0 NAME PLATE

Isolator, earthing switches and their operating devices shall be provided with name plate. The name plate shall be weatherproof and corrosion proof. It shall be mounted in such a position that it shall be visible in the position of normal service and installation. It shall carry the following informations duly engraved or punched on it.

A. Isolator Base

Name: AEGCL
Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage – Rated normal current –
Rated short time current (rms) and duration –
Rated short time peak current (KAP)
Weight

B. Earthing Switch

Name: AEGCL
Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage –
Rated normal current –
Rated short time current (rms) and duration
Rated short time peak current (KAP)
Weight

C. Operating Device

Name – AEGCL
Name of manufacturer –
Order No.
Type Designation –
Reduction gear ratio –
AC motor

i. Rated auxiliary voltage
ii. Starting current
iii. Designation of AC motor as per IS 4722/325
iv. Starting torque at 80% of supply voltage
v. Over travel in degrees after cutting off supply

Total operating time in seconds

i. Close operation – Electrical
ii. Open operation – electrical
iii. Open operation – manual

12.23.0 PAINTING GALVANIZING AND CLIMATE PROOFING

At interiors and exteriors of enclosures, cabinets and other metal parts (other than made up of aluminium) shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other adhering foreign matter and the surfaces treated by phosphating (e.g., seven tank phosphating sequence). After such preparation of surfaces, two coats of zinc oxide primer shall be given by suitable stoving and air drying before final painting. Colour of the final paints shall be of shade no. 697 of IS:5. The finally painted cubicle shall present aesthetically pleasing appearance free from any dent or uneven surface.

Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation.

All components shall be given adequate treatment of climate proofing as per IS:3202 so as to withstand corrosive and severe service conditions.

All metal parts not suitable for painting such as structural steel, pipes, rods, levers, linkages, nuts and bolts used in other than current path etc. shall be hot dip galvanized as per IS –2629. Galvanization test will be carried out during routine test.

Complete details of painting, galvanizing and climate proofing of the equipment shall be furnished in the offer.

12.24.0 TESTS

12.24.1 <u>Type Tests</u>

Isolators offered, shall be fully type tested as per the relevant standards. The Bidder shall furnish Three sets of the following valid type test reports for their different type of offered Isolators along with the offer. The Purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative. For this purpose, the Bidder may quote unit rates for carrying out each type test and this will be taken during bid price evaluation, if required.

a) short time withstand & peak withstand current test for Isolator & Earth Switch.

b) power frequency (Dry & Wet), Lightening Impulse dry withstand Test

c) Mechanical endurance Test

d) IP-55 test

During type tests the isolator shall be mounted on its own support structure or equivalent support structure and installed with its own operating mechanism to make the type tests representative. Drawing of equivalent support structure and mounting arrangements shall be furnished for Purchaser's approval before conducting the type tests.

The type tests shall be conducted on the isolator along with approved insulators and terminal connectors. Mechanical endurance test shall be conducted on the main switch as well as earth switch of one isolator of each type.

12.24.2 <u>Acceptance and Routine Test:</u>

All acceptance and routine test as stipulated in the relevant standards shall be carried out by the supplier in presence of Purchaser's representative.

Mechanical operation test (routine test) shall be conducted on isolator (main switch and earth switch) at the supplier's works as well as purchaser's substation site.

Immediately after finalization of the programme of type / acceptance, routine testing the supplier shall give sufficient advance intimation (clear 20 days advance intimation), along with shop routine test certificates, valid calibration reports from Govt. approved test house for the equipments, instruments to be used during testing for scrutiny by the purchaser to enable him to depute his representative for witnessing the tests. If there will be any discrepancies in the shop routine test certificates and calibration reports furnished by the firm then after settlement of the discrepancies only, purchaser's representative will be deputed for witnessing the tests. Special tests proposed to be conducted (if decided to conduct) as type test on isolators, are given at Annexure- II. These special type test charges shall be quoted along with all other type tests as per relevant IEC standard and these charges shall be included in the total bid price.

Test certificates of various items including but not limited to the following shall be furnished at the time of routine tests.

a) Chemical analysis of copper along with a copy of excise certificate indicating genuine source of procurement of electrolytic grade copper.
b) Bearings
c) Fasteners
d) Universal / swivel joint coupling
e) Insulators
f) Motor
g) Gears
h) Auxillary switch
i) Limit switch
j) Timer
k) Overload / single phase preventer relay
l) Interlocking devices
m) Terminal block
n) Any other item

12.25.0 INSPECTION

i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the disconnectors, earth switches and associated equipment are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the works raw materials manufacture of all the accessories and for conducting necessary tests as detailed herein.

ii) The supplier shall keep the purchaser informed in advance of the time of starting of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of the equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

12.26.0 QUALITY ASSURANCE PLAN

The Bidder shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection.

(i) Names of sub suppliers for raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Supplier's representative, copies of test certificate

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

(iii) List of manufacturing facilities available

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

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

(vi) List of testing equipments with calibration certificates from Govt. approved test house available with supplier for final testing equipment and test plant limitation if any, vis-à-vis the type, special acceptance and routine test specified in the relevant standards. These limitations shall be very clearly brought out in the specified test requirements.

The supplier shall within 30 days of placement of order, submit following information to the purchaser.

i) List of raw material as well as bought out accessories and the names of sub-suppliers selected from the lists furnished along with offer.

ii) Type test certificates of the raw material and both bought out accessories.

iii) Quality Assurance Plan (QAP) withhold points for purchaser's inspection.

The supplier shall submit the routine test certificates of bought out accessories and raw material viz. Copper, aluminum conductors, lubricating material, gear material etc. at the time of routine testing of the fully assembled isolator.

12.27.0 DOCUMENTATION

All drawings shall conform to relevant international standards organization (ISO). All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

List of Drawings and Documents

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

a) General outline and assembly drawings of the dis-connector operating mechanism, structure, insulator and terminal connector.

b) Sectional views and descriptive details of items such as moving blades, contacts, arms contact pressure, contact support bearing housing of bearings, balancing of heights, phase coupling pipes, base plate, operating shaft, guides, swivel joint operating mechanism and its components etc.

c) Loading diagram

d) Drawings with structure for the purpose of type tests.

e) Name plate.

f) Schematic drawing.

g) Type test reports.

h) Test reports, literature, pamphlets of the bought-out items and raw material.

The supplier shall within 2 weeks of placement of order submit four sets of final versions of all the above said drawings for Purchaser's approval. The purchaser shall communicate his comments / approval on the drawings to the supplier. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for Purchaser's approval within two weeks from the date of comments. After receipt of approval the supplier shall within three weeks submit 15 prints and two good quality re-producibles of the approved drawings for purchaser's use.

Six sets of the type test report, duly approved by the Purchaser shall be submitted by the supplier for distribution, before commencement of supply Adequate copies of acceptance and routine test certificates, duly approved by the Purchaser shall accompany the dispatched consignment.

The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier risk.

12.28.0 INSTRUCTION MANUALS

Fifteen copies of the erection, operation and maintenance manuals in English to be supplied for each type of disconnector one month prior to dispatch of the equipment. The manual shall be bound volumes and shall contain all drawings and information required for erection, operation and maintenance of the disconnector including but not limited to the following particulars.

(a) Marked erection prints identifying the component parts of the disconnector as shipped with assembly drawings.

(b) Detailed dimensions and description of all auxiliaries.

(c) Detailed views of the insulator stacks, metallics, operating mechanism, structure, interlocks, spare parts etc.

12.29.0 PACKING AND FORWARDING

The equipment shall be packed in crates suitable for vertical / horizontal transport, as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols.

Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

Each consignment shall be accompanied by a detailed packing list containing the following information:

(a) Name of the consignee.

(b) Details of consignment.

(c) Destination.

(d) Total weight of consignment.

(e) Handling and unpacking instructions.

(f) Bill of material indicating contents of each package.

The supplier shall ensure that the bill of material is approved by the purchaser before dispatch.

12.30.0 SUPERVISION OF ERECTION TESTING AND COMMISSIONING (ET&C)

Purchaser proposes to utilize the services of the supplier for supervision of testing and commissioning of the equipment being supplied by him, if it is required. For this purpose, the supplier should make available the services of trained personnel (Engineers) who shall correct in the field, any errors or omissions in order to make the equipment and material properly perform in accordance with the intent of this specification. The Engineer shall also instruct the plant operators in the operation and maintenance of the commissioned equipment. The supplier shall be responsible for any damage to the equipment on commissioning the same, if such damage results for the faulty or improper ET&C. Purchaser shall provide adequate number of skilled / semi-skilled workers as well as ordinary tools and equipment and cranes required for equipment erection, at his own expenses. Apart from the above, the Purchaser shall not be responsible for providing any other facilities to the supplier. Special tools if required for erection and commissioning shall be arranged by the supplier at his cost and on commissioning these shall be supplied to the purchaser free of cost for future use.

APPENDIX – I

(Isolators)

LIST OF SPECIAL TESTS TO BE CARRIED OUT IF DECIDED BY THE PURCHASER

Sl. No.	Name of the Test	Standard to which it conforms
1.	Test for visible Corona and Radio interference voltage (RIV) on disconnectors and terminal connector	NEMA Pub No. 107-1964 ISRI Pub No. 1-1972
2.	Tests on insulators	IS-2544 IEC. 168
3.	Tests on terminal connectors	IS:5561
4.	Tests on galvanized components	IS:2633
5.	Stalled torque test on motor operating mechanism	At 110% of supply voltage

SECTION – 13
TECHNICAL SPECIFICATION FOR SAMAST METER

Interface Energy Meters Technical Specification

1 Basic Features of Interface Energy Meters

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

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

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

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

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

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

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

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

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

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

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

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

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

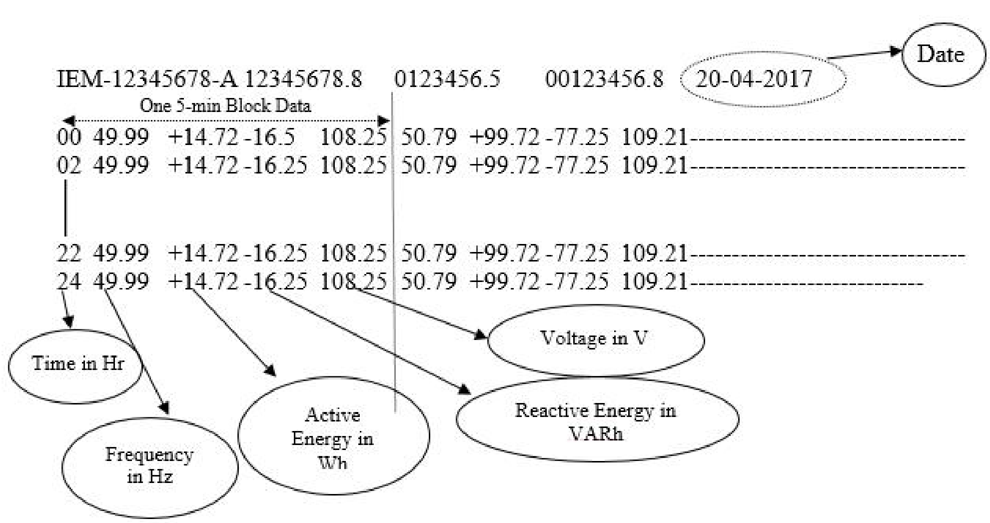

Figure 1: **Standard Raw Data Format for IEM**

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

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

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

2 Constructional Features

a) The meters shall be supplied housed in compact and sturdy, metallic or moulded cases of non-rusting construction and/or finish. The cases shall be designed for simple mounting on a plane, vertical surface such as a control/relay panel front. All terminals for CT and VT connections shall be arranged in a row along the meter's lower side. Terminals shall have a suitable construction with barriers and cover, to provide a secure and safe connection of CTs and VTs leads through stranded copper conductors of 2.5 sq. mm. size.

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

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

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

3 Measurement

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

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

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

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

v. The Reactive energy (VARh) measurement shall be carried out on 3-phase, 4-wire principle, with an accuracy of 0.5S as specified in IS 14697. The meter shall compute the net Reactive energy (VARh) sent out from the substation bus bars during each successive 5 min block, and store it in its memory up to fourth decimal with plus sign if there is net VARh export and with a minus sign if there is net VARh import.

It shall also display on demand the net VARh sent out during the previous 5 min block. Further VARh data in. NPC/output report shall be rounded off upto third decimal.

vi. The meter shall also integrate the reactive energy (VARh) algebraically into two separate registers, one for the period for which the average RMS voltage is above 103.0%, and the other for the period for which the average RMS voltage is below 97.0 %. The current reactive power (VAR), with a minus sign if negative, and cumulative reactive energy (VARh) readings of the two registers (>103% and <97%) shall be displayed on demand. The readings of the two registers at each midnight shall also be stored in the meter's memory. When reactive power is being sent out from substation bus bars, VAR display shall have a plus sign or no sign and VARh registers shall move forward. When reactive power flow is in the reverse direction, VAR display shall have negative sign and VARh registers shall move backwards. Generally, the standard PT ratios are 33kV/110V, 132kV/110V, 220 kV /110 V, 400 kV /110 V and 765 kV / 110 V. However, at the time of commissioning the vendor may confirm the same from site and configure the meter accordingly to ensure correct recording of reactive energy.

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

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

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

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

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

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

4 Memory/ Storage

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

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

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

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

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

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

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

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

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

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

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

<u>5 Display</u>

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

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

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

iii. Time (hour min sec /hh mm ss) : 195527 t
iv. Cumulative Wh reading : 1234567.8 C
v. Average frequency of the previous block: 49.89 F
vi. Net Wh transmittal during the previous block: - 28.75 E
vii. Net VARh transmittal during the previous block: - 18.75 R
viii. Average % Voltage: 99.2 U
ix. Reactive power (VAR) : 106.5 r
x. Voltage - high VARh register reading: 1234567.5 H
xi. Voltage - low VARh register reading: 1234567.4 L
xii. Low battery indication
xiii. The three line-to-neutral voltages shall be continuously monitored and in case any of these falls below 70 %, a preferably flashing three LEDs (one LED/phase) provided on meter's front shall become steady. They shall go off if all three voltages fall below 70 %. The LED shall automatically resume flashing when all VT secondary voltages are healthy again.
xiv. The two VARh registers (xv and xvi) shall remain stay-put while VT supply is unhealthy.

Any other better or more informative mechanism to display the above shall be preferred. The above shall be mutually agreed between the meter buyer and vendor.
Navigation keys to be provided at the meter front plate to navigate the display menu.

6 Communication

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

b). All meters shall be compatible with Optical port, RS-485 port, Ethernet port and USB / RS-232 port all together at a time and communicate independently. It shall also be possible to obtain a print out (hard copy) of all data collected from the meters, using the local PC. Data collection from any local laptop/PC shall be possible by installing data collection software. Entire project has to be based on Optic Fibre/GSM/4G/3G.
The Tenderer may design appropriate architecture for providing end to end metering solution. He is free to decide upon the best solution out of all the available options to ensure that data from all IEMs in ASSAM are available at State Load Despatch Centre by the scheduled time. However, the entire responsibility of fully functional end to end metering system shall rest with the Tenderer in order to meet the performance levels as given in this document. The communication provider may adopt Optical Fibre/GSM/3G/4G communication technology or a combination of these technologies as per the site requirement adopting best available technology in the proposed area of implementation. The successful Tenderer shall be responsible for proper data exchange among IEM, DCU, CDCS, MDP and other operational/requisite software as part of fully functional metering system.
The operational testing of all the network elements has to be demonstrated by the Tenderer to the satisfaction of the utility.
The Tenderer shall provide the necessary software which would enable a local PC/ CDCS to:
Accept the data from the Optical/Ethernet/WAN and store it in its memory in user defined formats (text, csv, xls, etc.) in a user-defined file name (file name format must be ddmmyy substation name-utility name).
Polling feature along with a task scheduler to run the data downloading software at a pre-designated date and time repeatedly or by manually selecting a meter. File naming for such downloaded data should also be in user-defined format. A detailed activity log shall also be available for each downloading operation.

Upload/Import meter data (binary files) in the software for further processing. While uploading, there shall be provision to upload all selected files with single key-stroke.
Convert the binary file(s) to text file(s). There should be provision to select multiple files based on filename, convert all selected files with single key-stroke and store the text files in the same location where binary files are stored.
Display the collected data on PC's screen in text format, with forward/backward rolling
Print out in text format the data collected from one or more meters, starting from a certain date and time, as per operator's instructions
Transmit the collected data, in binary format, through an appropriate communication link to the central computer, starting from a certain date and time, as per operator's instructions.
Store the collected data in binary format, on a CD/Pen Drive. In addition to above, in general the software shall be able to convert IEMs data to existing format as well as in tabular (.csv) format as applicable.
The above software shall further ensure that absolutely no tampering (except erasing of complete data with password protection) of the collected metering data is possible during its handling by the PC. The software shall be suitable for the commonly available PCs, (Windows) and shall be supplied to Owner in a compatible form to enable its easy loading into the PCs available (or to be installed by the Owner/others) at the various substations.
The Tenderer shall ensure data integrity checks on all metered data received from data collection systems.
The quality of installation of the various equipment & power supply wiring to all field equipment shall be as per standards/ regulations/prevailing practices of the utility. The supply of electricity needed for operation and maintenance of entire Metering system shall be provided free of cost by the respective owners of the premises.

7. Climatic Condition

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

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

8. Quality Assurance

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

9.0 Testing

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

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

c). Acceptance Tests for PC Software and data down loading using meter communication ports- All IEMs after final assembly and before despatch from Tenderer's/Manufacturer's works shall be duly tested to verify that they are suitable for downloading data using meter communication ports shall be subjected to the following acceptance test.
Downloading Meter Data from the Meter(s) to PC via optical port.
Downloading meter data through USB port and RS 232.
Downloading meter data to DCU/CDCS through Ethernet as well as RS 485 port.
Compatibility with PC Software.
Functioning of Time synchronisation, advance and retard time commands.
Per meter downloading time verification.

d). Copy of Certificate shall be submitted.

Type Tests

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

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

c). The Tenderer shall arrange all type testing specified above, and bear all expenses for the same.
d). Copy of Test certificate shall be submitted to SLDC.

10. ANOMALY DETECTION FEATURES

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

- Phase wise Current Circuit Reversal – The meter shall detect reversal of polarity provided the current terminals are reversed. This shall be recorded for 1 or 2 phase CT reversal.
- Voltage Unbalance – The meter shall detect voltage unbalance if there is unbalance in voltages.
- Current Unbalance – The meter shall detect current unbalance if there is unbalance in load conditions. Meter should ensure true system conditions before going for current unbalance checks.
- CT Miss – The meter shall detect current miss if the current is below a defined threshold, provided the phase voltage is above a specified threshold. Snapshots of phase wise voltage, phase wise active current and phase wise power factor shall be provided with above specified anomaly events. Further, each meter module shall record the following events along with total duration:
  Power On/Off – The meter shall detect power off if both the auxiliary supplies fail. The event shall be recorded on the next power up. At the same time power on event shall be recorded. No snapshot shall be logged with this event.

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

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

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

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

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

11. Warranty

- The IEM shall be under warranty as per OEM standard Warranty Policy. The Tenderer shall be responsible for meter testing as per CEA metering regulations.
- The warranty would include repair, replacement, part material replacement cost and one way (return) transportation cost (including insurance of transit)
- Meter software, if upgraded by OEM should be supplied free of cost with initiation taken from party. Remote service person name to be indicated during TENDERding
- Meters which are found defective/inoperative at the time of installation or become inoperative/defective within the warranty period, these defective/inoperative meters shall be replaced within one week of receipt of report for such defective/inoperative meters
- Copy of warranty certificate shall be submitted to owner

12. STANDARDS TO BE COMPLIED WITH

Standards to be complied

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

Each meter has a unique identification number and each meter location has unique Identification code. DCU shall collect data from a single or group of meters based on meter number and meter location code. DCUs shall collect data from energy meters and transfer the same to CDCS. DCUs should provide a RS-485/Ethernet/USB port for Communication with local personal computer or terminal.

SECTION-14
SCHEDULES
GUARANTEED TECHNICAL AND OTHER PARTICULARS
(To be filled in by Bidder)

1.0 GENERAL

S. No	Description	Details
1.1	Tender's name & address	
1.2	Manufacture' name & address for the following items	
i)	Power Transformer	NA
ii)	Current transformer	
iii)	Voltage transformer	
iv)	Surge arrestor	
v)	Power Cables	
vi)	Substation Automation System	
vii)	Circuit Breaker	
vii)	Control Panels	
ix)	Numeric Relays	
x)	Instruments	
xi)	D.C Timers	
xii)	Battery	
xii)	Battery Charger	
xi)	Other accessories	
1.3	Climatic condition for which the technical parameters are guaranteed	

i)	Altitude	
ii)	Ambient Temperature (Max & Min)	
iii)	Average rainfall per annum	
iv)	Max. humidity	
1.4	Tenderer’s proposal no. & date	
1.5	Name and address of tenderer’s representative from whom technical clarification can be obtained	

2.0 132/33 kV, 50MVA POWER TRANSFORMER

(This Schedule shall be filled in for each rating and type of Transformers)

Sl. No	Description	To be filled in by the Tenderer
1	Manufacturer's Name & Address of manufacturing plant	
2	Standard applicable	
3	Rating (MVA)	
4	Voltage ratio (kV)	
5	Winding connection	
6	Vector group	
7	Number of phases	
8	Frequency (Hz)	
9	Type of cooling	
10	**Rating available at any tapping with ONAN cooling**	
	(i). HV (MVA)	
	(ii). IV (MVA)	
	(iii). LV (MVA)	
11	**Rating available at any tapping with ONAF cooling**	
	(i). HV (MVA)	
	(ii). IV (MVA)	
	(iii). LV (MVA)	
12	**Rating available at any tapping with OFAF cooling**	
	(i). HV (MVA)	
	(ii). IV (MVA)	
	(iii). LV (MVA)	
13	**Permissible overload**	
14	**Impedance Data**	
14.1	Ohmic impedance at 75^0 C and rated frequency based on rated power on HV winding (%)	
	(i). HV/LV	
	➢ Principal tap	
	➢ Maximum tap	
	➢ Minimum tap	
14.2	Tolerance applicable to above impedance	
	(i). HV/LV	
	➢ Principal tap	
	➢ Maximum tap	
	➢ Minimum tap	
14.3	Zero sequence impedance (%)	
	(i) HV/Neutral	
	➢ Principal tap	
	➢ Maximum tap	
	➢ Minimum tap	

Sl. No	Description	To be filled in by the Tenderer
	(i). LV/Neutral	
	➢ Principal tap	
	➢ Maximum tap	
	➢ Minimum tap	
14.4	Minimum Air core impedance (%)	
15	**Guaranteed Losses & Tolerances**	
15.1	**Guaranteed Losses**	
	a) No load loss on principal tap at rated voltage and frequency (KW)	
	b) Load loss (Copper Loss) at rated HV and IV load without LV loading at principal tap at 75ºC (KW)	
	c) Cooler loss (KW)	
	d) Total loss (a+b+c) (KW)	
15.2	**Tolerances if applicable on above losses**	
	a) No load loss on principal tap at rated voltage and frequency (KW)	
	b) Load loss (Copper Loss) at rated HV and IV load without LV loading at principal tap at 75ºC (KW)	
	c) Cooler loss (K/W)	
	d) Total loss (a+b+c), (KW)	
16	**Cooling Equipment Details**	
16.1	Number of radiator bank and its rating as % of transformer cooling	
16.2	Radiator	
	a) Type of mounting	
	b) Material	
	c) Thickness	
16.3	Number of fans per radiator bank	
16.4	Temperature range for which setting is adjustable	
17	**Thermal Data**	
17.1	Temperature rise in top oil over an ambient of 50^0 C. (^{0}C)	
17.2	Temperature rise in winding by resistance measurement method	
17.3	Winding hotspot temperature over an ambient of50^0 C. (^{0}C)	
17.4	Core hotspot temperature over an ambient of 50^0 C. (^{0}C)	
17.5	Position of core hotspot	
17.6	Thermal time constant (Hours)	
18	**Maximum noise level at**	
18.1	ONAN cooling (dBA)	
18.2	Full load with 100% cooling (dBA)	
19	**Maximum partial discharge level at 1.5 pu (pC)**	
20	**Core**	
20.1	Manufacturer of core material	

Sl. No	Description	To be filled in by the Tenderer
20.2	Type of construction (core/shell)	
20.3	Diameter of the core (mm)	
20.4	Core area (mm^2)	
	a) Yoke	
	b) Wound limb	
	c) Unwound limb	
20.5	Core material and grade used	
20.6	Type of joint between core and yoke	
20.7	Thickness of stamping (mm)	
20.8	Percentage silicon content (%)	
20.9	Maximum flux density in core at rated frequency and at	
	a) 90% voltage (wb/sq.m)	
	b) 100% voltage (wb/sq.m)	
	c) 110% voltage (wb/sq.m)	
21	**Over excitation withstand time (secs.)**.	
21.1	1.05 Um	
21.2	1.25 Um	
21.3	1.50 Um	
22.0	**Winding**	
22.1	Type of winding	
	a) HV	
	b) LV	
22.2	Current density at rated load	
	a) HV	
	b) LV	
22.3	Conductor area	
22.4	a) HV	
22.5	b) LV	
22.6	Maximum current density under short circuit	
22.7	a) HV	
22.8	b) LV	
22.9	Magnetizing inrush current (Amps)	
22.10	No load current (Amps) at rated frequency and at	
	a) 90% voltage	
	b) 100% voltage	
	c) 110% voltage	
22.11	Voltage per turn for maximum flux density	
	a) HV (Volts)	
	b) LV (Volts)	
22.12	Resistance	
	a) HV (Ohms)	
	b) LV (Ohms)	
22.13	Number of turns in	

Sl. No	Description	To be filled in by the Tenderer	
	a) HV		
	b) LV		
22.14	Position of winding from the core(Enclose a sketch)		
	a) HV		
	b) LV		
22.15	Type of Conductor		
	a) HV		
	b) LV		
22.16	Maximum average radial compressive stress in the winding		
	a) For CTC/epoxy bonded conductor (N/sq.mm)		
	b) For paper insulated conductor (N/sq.mm)		
22.17	Insulation system		
	Min^{m} density of press board (gm/cc)		
	Min^{m} Density of paper (gm/cc)		
23	**Insulation Level of Winding**	HV	LV
23.1	Lightning impulse withstand voltage (kVp)		
23.2	Switching Surge withstand voltage (kVp)		-
23.3	Power Frequency withstand voltage (kV rms)	-	
24	**Short circuit withstand current & duration**		
24.1	Short circuit current for which transformer is designed to withstand in p.u of rated rms current		
	(i). HV		
	(ii). LV		
24.2	Withstand time for three phase short circuit at terminals (secs.)		
25	**Capacitance Values**		
25.1	HV to earth(pF)		
25.2	LV to earth(pF)		
26	**Tank**		
26.1	Type of Tank cover (Conventional / Bell)		
26.2	Material		
26.3	Approximate thickness of		
	(i). Sides (mm)		
	(ii). Bottom (mm)		
	(iii). Cover (mm)		
26.4	Type of Tank cover joint		
27	**Vacuum withstand capability of**		
27.1	Main tank (torr)		
27.2	Radiators and accessories (torr)		
28	**Pressure withstanding capability of**		
28.1	Main tank (torr)		

Sl. No	Description	To be filled in by the Tenderer		
28.2	Radiators and accessories (torr)			
29	**Gasket**			
29.1	Material			
29.2	Temperature withstand capability (°C)			
30	**Size of oil filter hose (mm)**			
31	**Bushings**	HV	LV	Neutral
31.1	Name of Manufacturer			
31.2	Rated Voltage (kV)			
31.3	Rated current (Amps)			
31.4	Total creepage distance (mm)			
31.5	Protected creepage distance (mm)			
31.6	Insulation Level			
	a) Lightning impulse withstand voltage (kVp)			
	b) Switching Surge withstand voltage (kVp)			
	c) Power Frequency withstand voltage (kV rms)			
31.7	Colour of porcelain			
31.8	Mounting			
32	**Bushing Current Transformer**	**HV**	**LV**	
	(i). Type or voltage class			
	(ii). Ratio			
	(iii). Accuracy class			
	(iv). Burden (VA)			
	(v). Accuracy limit factor			
	(vi). Knee point voltage (Volts) (minimum)			
	(vii). Maximum resistance of secondary winding			
	(viii). Maximum exciting (mA) current			
32.1	**Neutral Side**	**HVNeutral**	**LVNeutral**	
	(i). Type or voltage class			
	(ii). Ratio			
	(iii). Accuracy class			
	(iv). Burden (VA)			
	(v). Accuracy limit factor			
	(vi). Knee point voltage (Volts) (minimum)			
	(vii). Maximum resistance of secondary winding			
	(viii). Maximum exciting (mA) current			
33	**Clearances**			

Sl. No	Description	To be filled in by the Tenderer
33.1	Minimum clearance between phases and phase to earth	
	(i). In oil (mm)	
	(ii). In air (mm)	
33.2	Minimum clearance of HV winding to tank in oil (mm)	
33.3	Minimum clearance of HV winding to earth in oil (mm)	
33.4	Clearance between Core and Coil (mm)	
33.5	Clearance between coils (mm)	
33.6	Clearance between neutral to ground in air (mm)	
34	**Tap changing Equipment rating**	
34.1	Manufacturer & type designation	
34.2	Voltage class & current	
34.3	Number of steps	
34.4	Range	
34.5	Step voltage	
34.6	Electrical location of tapping (HV/LV)	
34.7	Rated voltage of drive motor (volts)	
34.8	No. of revolutions to complete one step	
34.9	Time to complete one step on manual/auto operation (secs.)	
34.10	Power required (kW)	
34.11	Insulation level of tap changer	
34.12	Short circuit withstand current	
34.13	Value of tie-in-resistor and connection m) arrangement (if provided)	
34.14	No load voltage appearing on	
	(i). Principal tap	
	(ii). Maximum tap	
	(iii). Minimum tap	
35	**Conservator**	
35.1	Total volume (Litres)	
35.2	Volume between highest and lowest levels	
36	**Air Cell (oil preservation)**	
36.1	Material of air cell	
36.2	Continuous temp. withstand capability of the air cell	
37	**Pressure Relief Device**	
37.1	Manufacturer & type designation	
37.2	No. of pressure relief device provided	
37.3	Operating pressure of pressure relief device	

Sl. No	Description	To be filled in by the Tenderer	
38	**Insulating Oil**		
38.1	Manufacturer of the Oil		
38.2	Standards applicable		
38.3	Type of oil (Non inhibited / inhibited)		
38.4	Moisture Content (ppm)	Before first filling	Before commissioning
38.5	Max. tan-delta value (at 90 deg. C.)		
38.6	Resistivity (ohm-cm)		
38.7	Breakdown Strength (kV)		
38.8	Interfacial tension at 20°C (min.)		
39	**Temperature Indicators**		
39.1	Oil Temperature Indicator		
	(i). Name of Manufacturer		
	(ii). Range		
	(iii). Accuracy		
39.2	Winding Temperature Indicator		
	(i). Name of Manufacturer		
	(ii). Range		
	(iii). Accuracy		
39.3	RWTI		
	(i). Name of Manufacturer		
	(ii). Range		
	(iii). Accuracy		
	(iv). Auxiliary supply used		
40	**On line oil drying system**		
40.1	Name of Manufacturer & type designation		
40.2	Number & Capacity of drying element for each transformer		
40.3	Moisture absorption capacity		
41	**On line dissolved hydrogen gas & moisture monitoring system**		
41.1	Name of Manufacturer & type designation		
41.2	Name of gases monitored		
41.3	Nos. of Potential free contacts for monitoring, Alarm, equipment healthiness etc		
42	**Buchholz Relay**		
42.1	Name of Manufacturer & type designation		
43	**Furnish details of processing of core coil assembly including drying method, temperature, vacuum level, clamping pressure**		

Sl. No	Description	To be filled in by the Tenderer
44	**Approximate dimensions**	
44.1	Tank (L x B x H) (mm)	
44.2	Overall dimensions with coolers (L x B x H) (mm)	
44.3	Shipping dimensions (L x B x H) (mm)	
44.4	Height for un-tanking (mm)	
44.5	Dimensions of largest package (L x B x H) (mm)	
45	**Weights of Transformer Components**	
45.1	Core (kg)	
45.2	Windings (Kg)	
45.3	Core & winding assembly (kg)	
45.4	Insulation (Kg)	
45.5	Tank and fittings (Kg)	
45.6	Oil (Kg)	
45.7	Untanking weight (heaviest piece) (Kg)	
45.8	Total weight (Kg)	
45.9	Weight of heaviest package (Kg)	
45.10	Total shipping weight (Kg)	
45.11	Parts detached for transport (furnish list)	
46	**Proposed filling medium for transportation from works to site**	
47	**Minimum draw bar pull required to move the transformer on level track (kg)**	
48	**Bimetallic Connections**	
48.1	Normal current rating (A)	
48.2	Short time current rating (A)	
48.3	Tensile strength (Kg)	
48.4	Maximum temperature limit	
48.5	Dimensional sketch enclosed indicating tolerances (Yes/No)	
48.6	Minimum clearance (mm)	
	- Phase to Phase	
	- Phase to Earth	
49	Name of Manufacture of Nitrogen Injection Fire Protection System	
50	Details of system equipments for NIFPS	
51	**Fire Extinguishing Cubicle (FEC) of NIFPS**	
51.1	Dimensions (LXBXH) mm	
51.2	Weight kG	
51.3	Capacity of Nitrogen cylinder	
51.4	Number of cylinders	

Sl. No	Description	To be filled in by the Tenderer
51.5	Pressure of Nitrogen filing	
51.6	Minimum distance of FE cubicle from the transformer	
51.7	Method of mounting	
51.8	Whether the following items are provided in FE cubicle. If so furnish make, type & other details.	
51.9	Contact manometer	
51.10	Pressure Regulator	
51.11	Oil Release Unit	
51.12	Gas release unit	
51.13	Oil drain assembly	
51.14	Pressure /limit switches	
51.15	No of contacts & spare contacts (NO & NC)	
51.16	Oil drain valve (above FEC)	
51.17	Make	
51.18	Type	
51.19	Size	
51.20	Type of metal	
51.21	Nitrogen Injection Valve (above FEC)	
51.22	Make	
51.23	Type	
51.24	Size	
51.25	Oil drain pipe	
51.26	Size	
51.27	Length	
51.28	Number of openings in the transformer tank	
51.29	Material	
52	**Control Box of NIFPS**	
52.1	Dimensions (LXBXH) mm	
52.2	Weight	
52.3	Type & Thickness of sheet steel	
52.4	Details of components provided in the control box	
52.5	Control voltage	
52.6	Method of mounting	
52.7	Whether audio and visual alarms provided?	
53	**Transformer Conservator Isolation Valve of NIFPS**	
53.1	Make	
53.2	Type	

3.0 33KV Indoor VCB Panel

Sl No	Particulars	To be filled in by the tenderer
1	**General:**	
	Name of the Company	
2	**Panel**	
	Type & Designation	
	Application Standard	
	Rated Voltage (KV)	
	Highest Voltage (KV)	
	Normal Current (Amps.)	
	Frequency (Hz	
	STC for 3 Sec. (KA/ 3 Sec)	
	Breaking Capacity (KA)	
	Making Capacity (KAp)	
	Power frequency withstand voltage (KV rms)	
	Impulse withstand voltage (KVp)	
	Degree of protection	
	Material of enclosure	
	Sheet thickness of load bearing members	
	Sheet thickness of doors & covers	
	Position of Mechanical & Electrical Emergency Trip Arrangement	
	Power cable termination height	
	Position of Power Cable Entry	
	Position of Control Cable Entry	
	Separate Bus Section Panel at the side of Bus Coupler	
	Separate Panel for both Bus PT as per Drawing	
	Degree of protection of HV compartment	
3	**Bus Bar**	
	Material	
	Shape	
	a) Main Bus	
	b) Earth Bus	
	Cross sectional area (Sq. mm)	
	Type of plating	
4	Normal Current currying capacity (Amps)	
	STC for 3 Sec. (KA/3 Sec)	
	Temp. Rise over ambient at normal current	
	Current density (Amps/ sq. mm)	
	Phase to Phase clearance (mm)	
	Phase to ground clearance (mm)	
	Type of insulation	
	Bus support insulator	
	Material	
	Dry Power frequency Withstand Voltage for one minute	
	Wet Power frequency Withstand Voltage for one minute	
	Impulse Withstand voltage	
	Creepage distance	
5	**Vacuum Circuit Breaker**	
	Make	
	Type	

Sl No	Particulars	To be filled in by the tenderer
	Reference Standard Arc	
	Quenching medium	
	Number of break per	
	phase Rated voltage	
	Highest voltage	
	Frequency	
	Normal Current	
	Breaking capacity	
	Making capacity	
	STC for 3 Sec.	
	Insulation level	
	Temp. Rise over ambient at normal current	
	Operating duty cycle	
	Single Phase Capacitor Breaking capacity	
	Three Phase Capacitor Breaking capacity	
	Line Charging Breaking capacity	
	Cable Charging Breaking capacity Minimum phase to phase clearance	
5	Minimum phase to ground clearance	
	Type of operating mechanism	
	Closing time	
	Opening time	
	Mechanical Endurance capacity	
	Electrical Endurance capacity	
	Operating mechanism	
	Type of isolation	
	Details of mechanical interlock provided	
	Interchangeability between I/C, Feeder & B/C (Yes/No)	
	No. contacts in Aux. Switch (NO &NC)	
	No. contacts in Limit Switch (NO &NC)	
6	**Vacuum Bottle**	
	Make	
	Rated voltage	
	Type and model no.	
	Normal current	
	Breaking capacity	
	Making capacity	
	STC for 3 Sec.	
	Maximum contact separation length	
	Minimum Mechanical life in no. of operation	
	Minimum Electrical Life in no. of operation at rated normal current	
	Minimum Electrical Life in no. of operation at rated full short circuit current	
	Power frequency withstand voltage (dry)	
	Impulse withstand voltage	
	Contact material	
	Type of plating	
	Contact pressure	
7	**Current Transformer**	
	Make	
	Reference Standard	
	Type	
	Rated voltage	

Sl No	Particulars	To be filled in by the tenderer
	Rated frequency	
	Insulation level	
	Continuous over load in %	
	Class of insulation	
	Ratio	Transformer :
		Bus Coupler:
		Outgoing :
	Class of accuracy	Transformer :
		Bus Coupler:
		Outgoing :
	Burden	
	STC for 1 Sec.	
	ALF of Protection core	
	ISF of Metering Core at lower ratio	
	Core identification	
8	**Potential Transformer**	
	Make	
	Reference Standard	
	Whether withdrawable Type (Yes/No)	
	Insulation level	
	Type of insulation	
	Winding connection	
	Rated voltage	
	Class of insulation Ratio	
	Class of accuracy	
	Burden per Phase	
	Core identification	
	Over Voltage Factor	
	Installation Position	
	Primary fuse rating	
9	**Terminal connector**	
	Make	
	Type	
	Size	
10	**Trip & Close coils**	
	Voltage & Wattage of Closing coil	
	Voltage & Wattage of Tripping coil	
11	**Control wire**	
	Make	
	Voltage Grade	
	Size	
	i) CT Circuit	
	ii) PT Circuit	
	iii) Other Circuit	
	Colour	
12	**Earth Bus**	
	Material	
	Shape	
	Size	
	Current rating	
	Current density	
	Type of plating	
13	Adaptor cable box arrangement for 33 KV Power Cable to Station Service Transformer.	
14	Painting Details	

Sl No	Particulars	To be filled in by the tenderer		
	Surface cleaning process			
	Paint thickness			
	Paint shed			
15	**Shipping dimension of equipment (mm)**	**Height**	**Width**	**Depth**
16	**Lifting Hooks provided (Yes/No)**			
17	**Accessories**			
	Spring Charging Handle (no.)			
	VCB Operating Handle (no.)			

4.0 CONTROL AND RELAY PANELS AND SAS

(This Schedule shall be filled in for each category of CR Panels)

A. Control & Relay Panel

Sl No	Technical Particulars	Unit	To be filled in by Tenderer
1.	**General**		
1.1	Panel Sheet thickness		
1.2	Overall dimensions		
	i) Width		
	ii) Depth		
	iii) Height		
	Total weight of the panel		
1.3	Whether panel type is simplex with swing front door		
1.4	Whether lockable glass cover provided		
1.5	Whether Rear side of panel is blocked		
1.6	Internal finish		
1.7	External Finish		
1.8	Control wiring		
	Material and Size of wiring For CT & PT circuit For other circuit		
1.9	Number of stranded in conductor		
1.10	Tinned/untinned		
1.11	Material of insulation and sheath		
1.12	Voltage grade of control wiring		
1.13	Numbered ferrules at both ends		
1.14	**Terminals**		
	a) Make		
	b) Current rating		
	c) Clamp type or bolt type		
	d)Maximum conductor size and number of conductor which it can receive		
	e) Disconnecting type of CT circuit		
	f) Terminal making facility provided		
	g) Crimp type connectors provided at the terminals		
	h) Spare terminals		
2.	**PROTECTIVE RELAYS**		
2.1	**Numeric over current / Earth fault relays**		
	a) Type		
	b) Current coil range		
	c) Tap range		
	d) Power consumption		
	i) Highest tap		
	ii) Lowest tap		
	e) Time of operation at maximum time dial setting		
	f) Type of characteristic		
	g) Whether draw out type or not		
	h) Trip contact rating Amps		
	i) Whether seal in contact provided or not		

Sl No	Technical Particulars	Unit	To be filled in by Tenderer
	j) Is the slope setting variable?		
	k) Disturbance recorder capacity in time duration		
	l) Number of event recording		
	m) Does it have LBB protection		
	n) Does it have frequency protection, describe		
	o) Does it have voltage protection, describe		
	o) Compliance with IEC61850protocol(Yes/No)		
	q) Numbers of Analogue inputs		
	r) Numbers of Binary inputs		
	s) Numbers of Binary outputs		
2.2	**Numeric Differential Relays**		
	a) Manufacturer's Name & address		
	b) Type		
	c) Current coil Rating		
	d) Tap Range		
	e) Maximum VA burden at:- (i) Operating coil (ii) Restraining coil.		
	f) Is the slope setting variable?		
	g) Harmonic restraint provided or not.		
	h)Range of HT/LT ratios over which the relay can be used.		
	i) Operating time		
	j) Trip contact rating.		
	k) Whether sealed in contact provided or not.		
	l) Does it have over fluxing feature		
	m)Disturbancerecordercapacityintimeduration		
	n) Number of event recording		
	o) Does it have REF functions		
	p) Does it have O/C & E/F protection		
	q) Does it have LBB protection		
	r) Does it have frequency protection		
	s) Does it have voltage protection		
	t) Does it have Over Load protection		
	t) Compliance with IEC 61850 protocol (Yes/ No)		
	u) Numbers of Analogue inputs		
	v) Numbers of Binary inputs		
	w) Numbers of Binary outputs		
2.3	**Numeric Distance Scheme, Main-I**		
	a) Manufacturer's Name & address		
	b) Type		
	c) Current coil Rating		
	d) Tap Range		
	e) Maximum VA burden at:- (i) Operatingcoil (ii) Restrainingcoil.		
	f) How many zones of protections, describe them		
	g) Minimum time of operation		
	h) Does it have mho/Quad characteristics		
	i) Does it have SOTF & PSB		

Sl No	Technical Particulars	Unit	To be filled in by Tenderer
	j) Does it have carrier aided protection		
	k) Does it have AR facility		
	l) Does it have directional O/C & E/F protection		
	q) Does it have LBB protection		
	r) Does it have frequency protection, describe		
	s) Does it have voltage protection, describe		
	t) Disturbance recorder capacity in time duration		
	u) Number of event recording		
	v)CompliancewithIEC61850protocol(Yes/No)		
	w) Numbers of Analogue inputs		
2.31	x) Numbers of Binary inputs		
	y) Numbers of Binary outputs		
	z) Does it have Tripping logic functions (Yes/No)		
	aa) Does it have Fault Locator functions (Yes/No)		
	ab) Does it have Broken Conductor check functions (Yes/No)		
	ac) Does it have Fuse Fail Supervisionfunctions (Yes/No)		
	ad) Whether it has df/dt function (Yes/No)		
	ae)WhetherU/Fissettableformultistage(Yes/No)		
	Fill up the as per item 2.3, with operating characteristic details		
2.4	**Auxiliary Relays**		
	a. Manufacturer's Name & address		
	b. Type		
	c. Rated current/voltage and permissible variation		
	d. Rated burden		
	e. No. and type of contacts (whether 'NO' or 'NC')		
	f. Rating of contacts		
	g. Total operating time of relays		
	h. One minute power frequency withstand voltage		
	i.Detailed literature furnished with reference (Yes/No)		
	j. Details of testing facilities provided		

B. BAY CONTROLUNIT

Sl No	Technical Particulars	Unit	To be filled up by Tenderer
1.	a) Manufacturer's Name & address		
	b) Size of the BCU		
	c) Disturbance recorder capacity in time duration		
	d)WhethertheBCUhasthecapabilitytocontroltwoor morebays		
	e) Size of HMI window		
	f) Numbers of Analogue input		
	g) Numbers of BI		
	h) Numbers of BO		
	i) Numbers of input/output modules		
	i)WhetherBCUhasSynchronizationfeatures,(Yes/No)		

Sl No	Technical Particulars	Unit	To be filled up by Tenderer
	j) Whether BCU has Auto Reclose features,(Yes/ No)		
	k) Whether BCU has OC& EF protection function (Yes/No)		
	l)Whether BCU has Trip Ckt Supervision facilities (Yes/No)		
	m) Number of event recording		
	n) Compliance with IEC61850 protocol (Yes/No)		
	p) Number of equipment it can handle		
	q) Speed of operation		
	r) Describe inherent protection functions, if any		
	s) Metering (Phase Current/Voltage, MW, MVAR, Freq, Phase angle etc)		
	t) Monitoring		
	u) Disturbance Recorder		
	v) Card extension provisions, BI & BO (yes/No)		
	w) Whether site configurable		
	x) Nos of front configurable LED		
	y) Whether Self Supervision features provided (yes/No)		
	z) Whether communication port is in front(yes/no)		
	aa) Power card redundancy (Yes/No)		
	ab) Min & Maximum range of auxiliary voltage		
	ac) Numbers of FO ports		
	ad) %Accuracy at 1% of $I_n$for metering		
	ae) Whether Bay mimic can distinguish the live & dead section of the bay (yes/ no)		

C. Managed EthernetSwitch

Sl No	Technical Particulars	Unit	To be filled in by Tenderer
1.0	a) Manufacturer's Name & address:		
	b) Size of the Switch		
	c) Redundant Power Card (yes/ no)		
	d) Numbers of FO ports for Bay Level switches		
	e) Numbers of FO & Copper ports for Station Level switches		
	f) Whether self-diagnostic features is available (Yes/No)		
	g) Whether Port Monitoring Software for Ethernet Switches will be provided (Yes/No)		
	h) Whether active port availability indication is available (Yes/No)		
	i) Name the Protocol used		
	k) Standards followed (list to be provided)		
	l)Auxiliary Power Supply (mention range & type of auxiliary voltage)		

D. Time Synchronization Device

Sl No	Technical Particulars	Unit	To be filled up by Tenderer
1.0	a) Manufacturer's Name & address:		
	b) Model No		
	b) Size of the device		
	c) Redundant Power Card (yes/ no)		
	d) Numbers of communication ports		
	e) Day Display Format		
	f) Time display Format		
	g) Date Format		
	h) Frequency display Format		
	i)Remote display Digit Height (shall be more than 100mm)		
	k) SCADA/RCCC Interface		
	l) Heat Load (BTU/hr)		
	m) Time Synchronization Protocol		
	n) Accuracy (shall be more than 20 ns)		
	p) Configuration Software		
	q) List the Accessories along with make.		
	r) Compliance to IEC 61850 Protocol (Yes/No)		

E. Substation AutomationSystem

Sl No	Technical Particulars	Unit	To be filled up by Tenderer
1.0	**General**		
1.1	**SAS Panel**		
	a) Size of the Panel		
	b) Number of Panel		
1.2	**HMI (Main, Redundant & DR Station)**		
	a) Manufacturer's Name & address		
	b) Model No		
	c) General Configurations		
	d) Redundant Power Supply Card (Yes/No)		
	e) Are all the input/output ports are hardware lockable (yes/no)		
	f) Size of the LED Monitor		
	g) Protocol used for HMI		
	n) Name the Protocols Compliant to		
	Are the HMIs are fire wall protected (yes/no)		
1.2	**Configuration of Mass Storage Device**		
1.3	**Gateways**		
	a) Manufacturer's Name & address		
	b) Model No.		
	c) Redundant power card (yes/no)		
	d) Compatible to IEC 68870-101/104 (Yes/No)		
	e) Time Synchronisation (yes/no)		
	f) Nos. of output ports		
	g) Whether the Gateways are expandable for future 4 numbers of bays? (yes/no)		
	h) Whether it is site configurable? (Yes/no)		

Sl No	Technical Particulars	Unit	To be filled up by Tenderer
1.4	**Printers** (Please provide the information regarding Manufacturer, basic configuration for Colour laser, Dot matrix & Line printers separately)		
1.5	**Furniture** (Please provide the information regarding Make, size etc for each item)		
1.6	**FO cable** (Please provide make, size, nos. of pair etc)		
	Patch/CAT cable (Please provide make, size, core, type etc)		
1.7	Nos. of Licensed SAS software including NMS to be provided?		
1.8	**INVERTER**		
	a) Manufacturer's Name & address		
	b) Model		
	c) KVA Capacity		

5.0 36 KV Double Break (DBR) Isolator

(This Schedule shall be filled in for each category of Isolator)

Sl no	Particulars	To be filled in by the Bidder
1	Type/installation	
2	Name of manufacturer and address	
3	Standards according to which isolators are manufactured	
4	Highest design voltage	
5	Frequency (Hz)	
6	Rated voltage (KV)	
7	Maximum current that can be safely interrupted by the isolator inductive and capacitive current	
8	Continuous current rating	
9	Rated short time current for 3 sec and 1 sec	
10	Rated peak short time current	
11	Current density at the minimum cross-section of	
	a) Moving blade	
	b) Terminal pad	
	c) Contacts	
	d) Terminal connector	
12	Maximum temperature rises of current carrying parts when carrying rated current continuously	
13	Derating factor	
14	Insulation level	
	a) Impulse withstand voltage	
	i) phase to earth	
	ii) isolating distance	
	b) Power frequency withstand voltage (KV peak)	
	i)Phase to earth	
	ii) isolating distance	
15	Minimum clearance in air	
	i)Between poles(mm)	
	ii)Between live part and earth	
	iii) Between adjacent poles	
	iv)on the same pole	
16	Design & Construction	
	i)no of insulators per pole	
	ii)No of breaks per pole	
	iii) Types of closing/opening mechanism	
	iv)contacts	
	a) Material and grade	
	b) Cross-sectional area	
	v)Moving Blade	
	a) Material and grade	
	b) Cross-sectional area	
	vi)Type of interlock	
	vii)Operating mechanism	
	a) Material and thickness control cabinet	
	b) Degree of protection	
	viii)Tandem pipe	
	a) Size class and no of pipes	
17	SUPPORT INSULATOR	
	Cantilever Strength (Kgf)	
	Min.Creepage Distance(mm)	
	Insulation Level: One minute Power frequency voltage withstand	

Sl no	Particulars	To be filled in by the Bidder
	test (KVrms)	
	Insulation Level: 1.2/50 micro-sec. Lightning Impulse Voltage withstand test (KVp)	
18	Voltage of Motor Drives	
19	Rated auxiliary supply voltage to coil for close & Open Operation	
20	Number and type of auxiliary contacts for	
	main blade	
	earth switch	
	Operating time for closing (secs.)	
	Operating time for opening (secs.)	

6.0 SURGE ARRESTOR

(This Schedule shall be filled in for each category of LA)

Sl No	Particulars	To be filled in by the tenderer			
		400KV	220KV	132KV	33kV
1	Name of Manufacturer				
2	Arrester Class & Type				
3	Applicable standard				
4	Rated arrester voltage (KV)				
5	Maximum Continuous Operating Voltage (KV)				
6	Nominal Discharge Current (KA with 8/20 micro-sec wave)				
7	Long Duration Discharge Class				
8	Minimum Energy Discharge Capability (KJ/KV)				
9	Maximum Switching current impulse residual voltage at i)1000Amps ii)250Amps				
10	Maximum residual voltage with 1 micro second current wave at 10kA (KV_p)				
11	Maximum residual voltage with 8/20 micro-sec wave (KV_p) i) 5KA ii) 10KA iii) 20KA				
12	Safe fault current (KA)				
13	Lightning Impulse withstand voltage of Arrester Housing with 1.2/50 micro-sec wave (KV_p)				
14	One minute power frequency withstands voltage of housing (ry/wet) KV rms				
15	High current short duration impulse withstand level with 4/10 micrsec wave (KA) Peak				
16	Pressure Relief Class				
17	Over voltage withstand capability a) 10 seconds b) 1 sec c) 0.1 sec				
18	a) Reference voltage (KV) b) Reference current(mA)				
19	Number of units per phase and rating of each unit				
20	Minimum total creepage distance(mm)				
21	Leakage current(mA)				
22	Total weight of Arrester (Kg)				
23	Maximum Cantilever strength of Surge Arrester(Including Wind Load)				
24	Overall Height of Surge Arrester(mm)				
25	Maximum distance from equipment to be protected by Surge Arrester (mm)				
26	Any other particulars				

7.0 400/220/132KV GIS

c

Sl No	Particulars	To be Filled in by Tenderer		
1	**General**			
2	Name of manufacturer (OEM)			
3	Country of Origin			
4	Delivery from (location)			
5	Type & Designation			
6	Type tested at Name of laboratory: Address of laboratory:			
7	Whether suitable for OUTDOOR installation or not			
8	Standards applicable			
9	i) No. of Phases			
	ii) Single or Three phase design	400KV	220KV	132KV
10	**Configuration**			
i	Number of Feeder bays			
ii	Number of transformer bays			
iv	Future extension possibility			
11	**Service conditions**			
i	Ambient Air Temp. in Deg. C			
ii	Max Temp. in Deg. C			
iii	Min Temp. in Deg. C			
iv	Daily Average Temp. in Deg. C			
v	Solar Radiation W/sqmtr			
vi	Altitude above MSL, in mtr			
vii	Pollution class			
viii	Creepage distance, in mm/kV			
ix	Relative humidity			
x	Condensation			
xi	Vibration level			
xii	Noise level			
xiii	Induced Electromagnetic Disturbance, in kV			
xiv	Seismic conditions			
a	Vertical			
b	Horizontal			
12	**Enclosure**			
i	Code of pressure vessel			
ii	Type of manufacturing			
iii	Design temperature in Deg.C			
iv	Material			
v	Material grade & applicable standard			
vi	Outside diameter in mm			
vii	Minimum Wall Thickness, in mm			
viii	Painting Shade & Thickness			
a	- External			
b	- Internal			
ix	Degree of Protection			

Sl No	Particulars	To be Filled in by Tenderer		
x	Inductance in H/mt			
xi	Capacitance in pF/mt			
xii	Resistance in Ohm/mt			
xiii	Expansion Bellow			
a	Material			
b	Min allowable adjustable displacement Longitudinal Transverse			
xiv	Sealing system			
a	Type			
xv	Estimated life in years			
xvi	Barrier			
a	Material			
b	Dielectric strength			
13	**Support Structure**			
i	Material			
ii	Minimum thickness of galvanizing			
iii	Foundation channels /Anchor bolts			
14	**Grounding**			
i	Grounding Material			
ii	Grounding of complete GIS			
iii	Grounding of individual compartment			
iv	Grounding at flange joints			
15	**System Parameters**			
i	Highest System voltage in kV			
ii	Rated voltage of System in kV			
iii	Rated voltage of Equipment in kV			
iv	Rated Insulation level Phase to Earth and between Phases			
a	One Min Power Frequency withstand voltage kVrms			
b	Switching impulse withstand voltage, kVp			
	- Phase to Earth			
	- Between Phases			
c	Lightning Impulse withstand voltage, kVp			
v	Rated Frequency			
vi	Rated current in Amp			
vii	Rated current at 50 °C (equipment) in Amp			
viii	Rated current at 50 °C (bus bar) in Amp			
ix	Rated short circuit withstand current kArms			
a	Duration in sec			
b	Peak, kAp			
x	Enclosure withstand time for an internal fault in sec.			
xi	Estimated total energy loss at			
	100 % of rated capacity			
	75 % of rated capacity			
	50 % of rated capacity			
	25 % of rated capacity			
xii	Measures taken to minimize Over Voltage			
xiii	Phase labeling			

Sl No	Particulars	To be Filled in by Tenderer		
xiv	**Auxiliary supply (AC Voltage, Frequency; DC voltage)**			
	-Operation			
	-Control			
	-Illumination & heater			
16	**Delivery conditions**			
i	Bays fully assembled at works			
ii	Dimensions of longest section for transportation			
iii	Weight of heaviest package			
iv	Pressure of SF6 gas during transportation			
v	SF6 gas monitoring system provided during transportation			
17	**Bus Bar**			
i	Configuration (Single/double)			
ii	Nos of Phases			
iii	Material			
iv	Size			
v	Rating			
vi	Current density adopted			
vii	Current density as per type test report			
viii	Short time current withstand rating in kA			
ix	Duration			
x	Resistance per phase			
xi	Surge impedance			
xii	SF6 immersed insulator			
a	Material			
b	Dielectric strength			
xiv	Maximum Partial Discharges measured at HSV			
18	**SF6 Gas**			
i	Applicable standard			
ii	Quantity of SF6 Gas of complete GIS at filling pressure, in kg			
iii	Quantity of SF6 Gas of **largest** compartment GIS at filling pressure, in kg			
iv	Nos of Gas compartments			
v	Quantity of SF6 Gas of **individual** compartment GIS at filling pressure, in kg			
vi	Maximum permissible dew point, in Deg.C			
vii	Composition of Gas			
a	SF6 > 99.90 % by weight			
b	Air < 500 ppm by weight (0.25 vol.-%)			
c	CF4 < 500 ppm by weight (0.1 vol.-%)			
d	H2O < 15 ppm by weight (0.012 Vol-%)			
e	Mineral oil < 10 ppm by weight			
f	Acidity, in terms of HF < 0.3 ppm by weight			

Sl No	Particulars	To be Filled in by Tenderer		
g	Hydrolysable fluorides, In terms of HF < 1 ppm by weight			
	PRESSURE			
viii	Design pressure			
a	Circuit breaker			
b	Other compartments			
ix	Rated filling pressure			
a	Circuit breaker			
b	Other compartments			
x	Type tested pressure.			
a	Circuit breaker			
b	Other compartments			
xi	Routine test pressure			
a	Circuit breaker			
b	Other compartments			
xii	Operating pressure of PRD			
a	Circuit breaker			
b	Other compartments			
xiii	Alarm Pressure			
a	Circuit breaker			
b	Other compartments			
c	CB lock out Pressure			
d	Over pressure signaling			
xiv	Maximum SF6 Gas leakage rate, in % per year			
xv	Density Monitor to be provided for each Individual gas compartment.			
19	**Circuit Breaker**			
i	Applicable standard			
ii	Type			
iii	Designation			
iv	Operating Mechanism type			
v	Nos. of phases			
vi	Rated current in Amp			
vii	Mechanical Endurance class			
viii	Electrical Endurance class			
ix	Restrike probability class			
x	Rated SC breaking current			
xi	Rated SC breaking current - single phase test			
xii	Rated Line charging breaking current			
xiii	Rated Cable charging breaking current			
xiv	Capacitor bank switching capability, BC1 BC2			
xv	Inductive current			
xvi	Reactive current			
xvii	Out of phase making & breaking current			
xviii	Rated short line fault current			
xix	TRV characteristic			

Sl No	Particulars	To be Filled in by Tenderer		
xx	First Pole to Clear factor			
xxi	Nos. of interrupters per phase			
xxii	Type of arc control device provided, if any			
xxiii	Type of arcing contacts			
xxiv	Material of main contact			
xxv	Material of Arcing contacts			
xxvi	Filter material			
xxvii	Timings of operations			
a	- Opening at nominal control voltage			
	- Opening at minimum control voltage			
b	Closing time at nominal control voltage			
xxviii	Rated operating duty cycle			
xxix	Tripping Coils			
	- No of coils			
	- Rated Voltage			
	- Rated Current			
	- Rated Watts			
	- Resistance			
xxx	Closing Coil			
	- Rated Voltage			
	- Rated Current			
	- Rated Watts			
	- Resistance			
xxxi	Spring Charging Motor			
	- Rated Voltage			
	- Rated Current			
	- Rated Watts			
xxxii	Spring charging time at rated Aux supply			
xxxiii	Spring charging time at min Aux supply			
xxxiv	Maintenance required after nos. of operation at			
i	No load			
ii	Rated current			
iii	25% of rated SC current			
iv	50% rated SC current			
v	Rated SC current			
e	Provision of anti pumping			
f	No of operations after switching off of motor Aux. supply			
xxxvi	Provision of Manual trip			
xxxvii	Electrical interlocking			
xxxviii	Padlocking			
xxxix	Type of Operation counter provided			
20	**DISCONNECTORS**			
i	Applicable standards			
ii	Type			
iii	Rated current in Amp for			
	- Bus disconnector			
	- Line disconnector			
	- PT disconnector			
iv	Maximum Current that can be safely interrupted by the Isolator (Amp).			
	- Inductive			
	- Capacitive			
v	Rate Short time withstand Current in kA, for 3 sec			

Sl No	Particulars	To be Filled in by Tenderer		
vi	Rated peak short time Current, kAp			
vii	Rated bus charging current, in Amp			
viii	Type of contacts			
ix	Material of contacts			
x	Current Density at minimum cross section (A/mm2)			
xi	Rated lightning impulse withstand voltage across the open gap, kVp			
xii	Rated Power Freq withstand voltage across the open gap, kVrms			
xiii	Mechanical Endurance class			
xiv	Type of Operating Mechanism			
xv	Operating Motor details			
	- Type			
	- Rated Voltage			
	- Rated Current			
	- Rated Watts			
xvi	Operating Time - Closing - Opening			
xvii	Mechanical indication on drive shaft			
21	**Maintenance Grounding Switch**			
i	Applicable standards			
ii	Type			
iii	Rate Short time withstand Current in kA, for 3 sec			
iv	Rated peak short time Current, kAp			
v	Rated lightning impulse withstand voltage across the open gap, kVp			
vi	Rated Power Freq withstand voltage across the open gap, kVrms			
vii	Type of Operating Mechanism			
viii	Operating Motor details			
	- Type			
	- Rated Voltage			
	- Rated Current			
	- Rated Watts			
xi	Operating time -Closing -Opening			
x	Mechanical indication on drive shaft			
22	**Fast Acting Grounding Switch**			
i	Applicable standards			
ii	Type			
iii	Rate Short time withstand Current in kA, for 3 sec			
iv	Rated peak short time Current, kAp			
v	Rated induced current switching capability Rated capacitive current switching capability			
vi	Rated lightning impulse withstand voltage across the open gap, kVp			
vii	Rated Power Freq withstand voltage across the open gap, kVrms			
viii	Electrical Endurance class			
ix	Type of Operating Mechanism			
x	Operating Motor details			
	- Type			
	- Rated Voltage			

Sl No	Particulars	To be Filled in by Tenderer		
	- Rated Current			
	- Rated Watts			
xi	Operating Time			
	- Closing - Opening			
xii	Mechanical indication on drive shaft			
23	**Current transformers**			
i	Type			
ii	Material			
iii	Position of Current Transformer			
iv	Reference Standard			
v	Rated Continuous thermal current			
vi	Rated Short Time current			
vii	Duration			
a	**Feeder/Transformer/ Bus coupler Bay CT**			
i	Metering Core			
	- Ratio			
	- Output Burden			
	- Accuracy Class			
	- ISF			
ii	Protection Core			
	- Ratio			
	- Output Burden			
	- Accuracy Class			
	- ALF			
24	**Voltage Transformer**			
	Type			
	Position of Voltage Transformer			
	Reference Standard			
	Rated Over Voltage Factor - Continuous			
	Short Time Over Voltage Factor			
	Duration			
	Partial Discharge Level			
	Thermal Rating of Primary Winding			
25	**Local Control Cubical**			
i	Name of Manufacturer (OEM of GIS)			
ii	Location in GIS			
iii	Material			
iv	Sheet Thickness			
v	Degree of Protection			
vi	Padlocking arrangement			
vii	Major components of LCC			
	- Bay control mimic diagram			
	- Control Switches			
	- Indicating Lamps			
	- Position indicators			
	- Annunciation scheme			
	- Auxiliary relays			
	- Contact multiplication relays			
	- System parameters display			
	- Heater with thermostat			
	- Interface terminal blocks for relaying & protection			
26	**Maintenance**			

Sl No	Particulars	To be Filled in by Tenderer		
i	Maximum down time for replacement or removal of any part			
ii	Maximum down time for degassing and re- filling the biggest compartment			
iii	Time between two refilling of SF6 gas.			
iv	Recommended period for overhauling			
v	Operation and Maintenance manual attached			
vi	Nearest local service centre			
vii	Minimum time of availability of local service			
viii	Availability of spares at local service centre			
ix	List of recommended spares attached?			
x	List of recommended special tools, etc attached			
xi	List of commission spares attached?			
xii	List of maintenance spares attached?			

420/245/145 KV SF6 Gas filled Bushing

1	Rated Voltage			
2	Highest System Voltage			
3	One minute Power Frequency Voltage @ 50Hz			
4	Impulse Voltage (1.2/ 50 micro sec)			
5	Rated Current			
6	Maximum Service Current @ ambient of 40°C			
7	Rated Short Circuit Current			
8	Partial Discharge Extinction Voltage			
9	Partial discharge level			
10	Filling Pressure at 20 deg C			
11	Minimum Service Pressure at 20 deg C			
12	Max. Service Pressure at 20 deg C			
13	Test pressure at 20 deg C			
14	Maximum Allow leak rate per annum			
15	Arcing Distance			
16	Creepage Distance (Minimum)			
17	Specific Creepage Distance			
18	Mechanical Load			
19	Maximum Mechanical Load			
20	Maximum Earthquake acceleration (Horizontal and Vertical)			

8.0 SOLID CORE INSULATOR (Post Insulator)

Sl No	Particulars	Unit	To be filled in by the tenderer			
			400KV	220KV	132KV	33kV
1	Highest system voltage	kV				
2	Height of unit	mm				
3	Bending strength (approximate failing load): a) Upright	Kgf				
4	Tensile strength (Approximate)	Kgf				
5	Compression strength (Approximate)	Kgf				
6	Torsion strength (Approximate)	KgfM				
7	a) Power frequency flashover voltage (dry) b) (wet)	kV				
8	a) Impulse flashover voltage (Positive) b) (Negative)	kV				
9	a) One min PF withstand voltage (dry) b) (wet) (w/o arcing horns)	kV				
10	Impulse positive/negative withstand voltage	kV				
11	Power frequency puncture voltage	KV				
12	RIV a) Test V to Ground KV rms b) at 1000 KHz with grading rings	kV mV				
13	(a) Visible discharge (b) Switching surge withstand voltage	kV KV_p				
14	Creepage distance a) Total b) Protected	mm				
15	Top metal fitting PCD	mm				
16	Bottom metal fitting PCD	mm				
17	All ferrous part should be hot dip galvanized to IS:2629/1966	Y/N				
18	Suitable for Hot line washing	Y/N				
19	Corona Extinction device					
20	Dry Arcing Distance	mm				

9.0 FIRE PROTECTION AND FIRE FIGHTING SYSTEM

Sl.No.	Particulars	To be filled in by the Tenderer
1	Name and Address of the Fire Protection System Supplier	
2	No. of Fire Protection System executed by the supplier and duration of successful operation for each type of Fire Protection System	
	a. Automatic HVW/MVW spray type Fire Protection System	
	b. Automatic hydrant type Fire Protection System	
3	Portable Fire Fighting Equipment	
	a. Maker's Name & Address	
	b. Standards to which conform	
	c.Type&Designation	
	d.Capacity	
	e.Mounting details	
	f. Total quantity of different type	
4	Water Hydrant System	
5	Standby Diesel Engine Driven Pump	
6	Fire detection system	
7	Water supply System	
8	Instrumentation & Control System	
9	Annunciation System	

10.0 DISC INSULATOR

Sl. No.	DESCRIPTION	To be filled in by the Tenderer			
		70 KN	90 KN	120KN	160 KN
1.	Manufacturer's name & address				
2	Type of Insulator				
3	Size of ball & socket				
4	Dimensions				
(a)	Disc diameter				
(b)	Unit spacing				
(c)	Creepage distance of the single insulator-mm				
5	Electro-mechanical strength of single insulator-kN				
6	Materials of shell				
7	**Electrical value**				
7.1	Power frequency Withstand Voltage Disc				
	(a) Dry-kV (rms)				
	(b) Wet-kV (rms)				
7.2	Power frequency Withstand Voltage Disc				
	(a) Dry-kV (rms)				
	(b) Wet-kV (rms)				
7.3	Impulse Withstand Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)				
	(b) Negative – kV(Peak)				
7.4	Impulse Flashover Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)				
	(b) Negative – kV(Peak)				

11.0 XLPE CABLE

A. XLPE CABLE

Sl. No.	Particulars	To be filled in by the tenderer			
		400kV	200kV	132kV	33kV
1	Manufacturer's Name and Address				
2	Type of cable				
3	Conforming Standard				
4	No. of Cores				
5	**Voltage**				
i	Rated Voltage (U_0/U)				
ii	Highest System Voltage				
6	System Current				
7	Maximum Conductor temperature for continuous operation				
8	Maximum short time conductor temperature with duration				
9	Maximum allowable conductor temp. during overload				
10	**Details of Conductor**				
i	Conductor material and grade				
ii	Shape of conductor				
iii	Diameter (mm)				
iv	Cross sectional area (sq.mm)				
v	No. of Strands and Diameter of each Strand				
11	Water swellable powder/yarn provided				
12	Core Insulation				
i	Type of insulation				
ii	Diameter over insulation (mm)				
iii	Nominal thickness (mm)				
iv	Designed maximum stress				
v	Detail of vulcanization process				
13	Extruded Conductor Screen				
i	Material				
ii	Nominal thickness (mm)				
iii	Diameter over Conductor Screen (mm)				
iv	Resistivity (ohm-m)				
vi	Designed maximum stress at Conductor Screen				

Sl. No.	Particulars	To be filled in by the tenderer			
		400kV	200kV	132kV	33kV
14	**Extruded Insulation Screen**				
i	Material				
ii	Thickness (Nominal/Minimum)				
iii	Diameter over Insulation Screen				
iv	Strippable/ Bonded				
15	**Conducting Longitudinal Water Sealing**				
i	Material				
ii	Thickness				
16	**Metal Sheath/ Screen**				
i	Material				
ii	No. of Strands				
iii	Diameter of Cable after stranding				
17	**Armouring**				
i	Type				
ii	Material				
iii	Diameter over Armouring (mm)				
18	Nominal overall Diameter of Cable				
19	Nominal overall Weight of Cable per Metre				
20	Minimum Bending Radius allowable during installation				
21	Bushing Type (if applicable)				
22	Rated Power Frequency Withstand Voltage (1 min)				
23	Impulse withstand BIL (1.2/ 50/ micro-Sec) Line to earth				
24	Switching impulse voltage (250/ 2500 micro-sec)				
25	Rated short time withstand current (1 sec)				
26	Rated peak withstandcurrent (1 sec)				
27	Fault Level				
28	**Drum details**				
i	Material and Weight of Drum				
ii	Weight of Drum with Cable				
iii	Approximate length of cable in a drum				
iv	Flange diameter (mm)				
v	Barrel diameter (mm)				
29	Safe pulling force (kg/sqmm)				

B. INDOOR/OUTDOOR TERMINATION & STRAIGHT THROUGH JOINT

Sl.No.	Particulars	Details to be filled in by the tenderer
1	Name of Manufacturer	
2	Applicable Standards	
3	Rated Voltage of Cable accessories	
4	AC / DC Voltage Withstand (Dry)	
5	AC Voltage Withstand (Wet) (for Outdoor termination)	
6	Partial Discharge	
7	Impulse Voltage	
8	Load Cycle test	
	a. Each cycle heating duration	
	b. Temperature	
	c. Cooling Duration	
	d. Continuous Phase to earth Voltage withstand	
9	Humidity Test	
10	Salt Fog Test	
11	Thermal Short Circuit test	
12	Dynamic Short circuit test	
13	Method of Stress Control	
14	Tubing's &Molded parts	
15	Non-Tracking material	
16	Di-electric strength of insulating material	

12.0 Aluminium IPS Tube BUS

Sl no	Description	Details to be filled in by the tenderer		
		4 inch	3 inch	2.5 inch
1.0	**BUS PIPES: GENERAL**			
1.1	Name & address of Manufacturer			
1.2	Conforming Standard			
1.3	Type of tube			
1.4	Material & grade			
1.5	Manufacturing length in (mm)			
1.6	0.2% proof stress (yield strength) kg/mm2:			
1.7	% min. Elongation on 50 mm gauge length			
2.0	Chemical composition of material			
2. 1	Cu (%)			
2.2	Mg (%)			
2.3	Si (%)			
2.4	Fe (%)			
2.5	Al (%)			
3	Area for4inch,3inch, 2.5-inch I.P.S. tubes separately (mm^2)			
4	Weight for the above items separately (Kg/m)			
5	Minimum Ultimate tensile strength (Kg/mm^2)			
6	Modulus of Elasticity (Kg/mm^2)			
7	Thermal conductivity (calories/sec./Cm^2/ ^oC at 100^oC)			
8	Linear temperature co-efficient of expansion (20^oC – 200^oC) (/^oC)			
9	Temperature Co-efficient of resistance (/^oC)			
10	Rated normal current (Amps.)			
11	Temp. rise above ambient temperature of 50oC at rated normal current (^oC)			
12	Short time Current rating in KA (3 for second for 132/220/400 KV)			
13	Electrical resistivity (Maxm) at 20^oC (ohm-cm)			
14	D.C. resistance (Max.) at 20^oC (Micro-Ohm)			
15	Minimum Electrical Conductivity (% I.A.C.S.)			

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13.0 AAAC POWER CONDUCTOR

Sl. No	DESCRIPTION	TO BE FILLED IN BY THE TENDERER
1.0	Name of manufacturer and address for: (a) Aluminium Alloy rods: (b) Aluminium Alloy Conductor:	
2.0	Applicable Standard for: (a) Aluminium Alloy rods: (b) Aluminium Alloy Conductor:	
	No of Strand x Size, (No. x mm)	
3.0	Conductor over all diameter, (mm)	
4.0	Total sectional area, (mm^2)	
5.0	Approx. weight, (kg/kM)	
6.0	Minimum UTS, (kN)	
7.0	Modulus of Elasticity (Final), (kg/cm^2)	
8.0	Coefficient of linear expansion, (per^{0}C)	
9.0	Calculated maximum resistance of Conductor at 20°C, (ohm/Km)	
10.0	Lay Ratio: (i) 6 wire layer (max/min) (ii) 12 wire layer (max/min) (iii) 18 wire layer (max/min)	
11.0	Particulars of Aluminium Alloy Wires (strands)	
	(a) Wire Diameter, (mm) (i) Standard: (ii) Maximum: (iii) Minimum:	
	(b) Resistivity of wire, (ohms.mm^2/m)	
	(c) Density	
	(d) Co-efficient of Linear expansion (per^{0}C)	
	(e) Cross Sectional area of Aluminium wire	
	(f) Approximate Total weight of each strand, (kg/km)	
	(g) Calculated resistance at 20°C (D.C.), (ohms/km)	
	(h) Minimum Breaking Load of each strand, (kN)	
	(i) Minimum elongation on a gauge length of 200 mm	

14.0 ACSR POWER CONDUCTOR

Sl. No.	Description	Unit	To be filled in by the bidder
1.0	Maker's Name, Address		
2.0	Particulars of Raw Materials		
2.1	Aluminium		
a)	Minimum Purity of aluminum	%	
b)	Maximum Copper Content	%	
2.2	Steel Wires/Rods		
a)	Carbon	%	
b)	Manganese	%	
c)	Phosphorus	%	
d)	Sulphur	%	
e)	Silicon	%	
2.3	Zinc		
a)	Minimum Purity of Zinc	%	
3.0	Aluminum Strands after stranding		
3.1	Diameter		
a)	Nominal	mm	

Sl. No.	Description	Unit	To be filled in by the bidder
b)	Maximum	mm	
c)	Minimum	mm	
3.2	Minimum Breaking Load of Strand	kN	
3.3	Maximum Resistance of 1m length of	Ohm	
4.0	Steel Strands after stranding		
4.1	Diameter		
a)	Nominal	mm	
b)	Maximum	mm	
c)	Minimum	mm	
5.0	Galvanizing		
a)	Minimum weight of zinc coating per Uncoated wire surface	gm/m^2	
b)	Minimum number of one-minute dips galvanized strand can withstand in the preece test	Nos.	
c)	Minimum number of twists in a guage length times dia of wire which the strand can in the torsion test (after stranding)	Nos.	
6.0	ACSR Stranded Conductor		
6.1	UTS of Conductor	kN	
6.2	Lay ratio of Conductor	Max.	
a)	Outer Steel Layer		
b)	12 wire aluminumlayer		
c)	18 wire aluminumlayer		
d)	24 wire aluminumlayer		
6.3	D.C. resistance of conductor at 20^{o}C	Ohm/Km	
6.4	Standard length of conductor	M	
6.5	Maximum length of conductor that can be	Meter	
6.6	Tolerance on standard length of conductor	%	
7.0	Direction of lay for outside layer		
7.1	Linear mass of the Conductor		
a)	Standard	Kg/Km	
b)	Minimum	Kg/Km	
c)	Maximum	KgKm	
8.0	No. of Cold pressure butt welding available at works	Nos.	