SPECIFIC REQUIREMENT'S (Section- Project)
C/ENGG/SPEC/SEC-PROJECT/SPECIFIC REQUIREMENT REV NO 10

Employer has standardized its Specific Requirement for various equipment and works for different voltage levels. Items or clauses, which are not applicable for the scope of this package as per schedule of quantities described in BPS or as per scope defined elsewhere in Section Project, the technical specification/clauses for the items specified below should not be referred to.

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
A.	**Section: GTR Rev 15**	
1.	Clause 2.1 (a)	"All equipment/materials/items, as per **Annexure-K (Rev 01),** as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only with Minimum Local Content for individual items as listed in the above annexure. Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor. The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract."
2.	New Clause no 2.1 C	Equipment/Material/Items from a Indian manufacture who have specified transfer of technology (TOT) arrangement with an entity from a country which shares land border with India shall be accepted only if the Indian Manufacturer is complying the requirement of prevailing Guideline by Government of India under Rule 144(xi) of the General financial Rule (GFR) 2017
3.	New Clause No. 4.7	**Planning and Designing in purview of Vulnerability Atlas of India** Vulnerability Atlas of India (VAI) is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/UT wise hazard, maps with respect to earthquakes, winds and floods for district wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation stage. This Atlas is one of its kind single point source for the various stakeholders including policy makers, administrators, municipal commissioners, urban managers, engineers, architects, planners, public etc. to ascertain proneness of any city/ location/ site to multi-hazard which includes earthquakes, winds, floods thunderstorms, cyclones and landslides. While project formulation, approvals and implementation of various urban housing, buildings and infrastructures schemes, this Atlas provides necessary information for risk analysis and hazard assessment. The Vulnerability Atlas of India has been prepared by Building Materials and Technology Promotion Council under Ministry of Housing and Urban Affairs, Government of India and available at their website https://www.bmtpc.org/. It is mandatory for the bidders to refer Vulnerability Atlas of India for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning and designing the project in terms of: i) Seismic zone for earthquakes, ii) Wind velocity iii) Area liable to floods and Probable max. surge height iv) Thunderstorms history v) Number of cyclonic storms/ severe cyclonic storms and max sustained wind specific to coastal Region vi) Landslides incidences with Annual rainfall normal vii) District wise Probable Max. Precipitation
4.	New Clause No. 8.3	**8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE** 8.3.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site www.powergrid.in after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		proposed sub vendor by Contractor along with the enclosures as per **Annexure-F Rev 01** shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor. For Telecom/GA&C packages, the makes/model of small items shall be finalized during approval of DRS by Telecom/GA&C department. The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-G Rev 01** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item. Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order. A Copy of MQP format is placed at **Revised Annexure – M.** Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/ POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian / International standards. **Inspection Levels:** For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below: **Level –I:** Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers. **Level – II:** Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports / certificates. **Level - III:** Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections (if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID. **Level – IV:** Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID. 8.3.2 Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP). 8.3.3 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 Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorized representative permission

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		to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations. 8.3.4 Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor within 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board. 8.3.5 The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports. 8.3.6 Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule. 8.3.7 Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works. 8.3.8 Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection. 8.3.9 Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch . 8.3.10 The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract. 8.3.11 All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission. 8.3.12 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from

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		proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.
		8.3.13 In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspection Engineer or to his authorized representative to accomplish testing.
		8.3.14 The inspection and acceptance 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, or if such equipment is found to be defective at a later stage.
		8.3.15 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
		8.3.16 The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.
		8.3.17 Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipment under Re-Work/Re-Engineering along with procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.
		8.3.18 Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.
		8.3.19 Contractor shall ensure that all possible steps are taken to avoid damage to the equipment during transport, storage and erection.
		8.3.20 Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per POWERGRID approved guidelines/Technical specifications.
		8.3.21 Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable
		8.3.22 For EHV transformers/reactors: Insulation oil shall be as per POWERGRID Technical specifications and same grade shall be used for impregnation of the active part & testing at the works of Transformer/Reactor Manufacturer and as well as for filling the Transformer/Reactors at site. Contractor to ensure that windings for Transformer/Reactors are made in air-conditioned environment. Core-coil assembly shall be performed in positive pressurized dust-controlled environment. Dust measurements shall be monitored regularly at Transformer / Reactor Manufacturer works. Contractor shall ensure that respective civil foundations & Fire walls for Transformer/Reactors units to be commissioned, shall be made ready at concerned sites before receipt of Transformer/Reactors units. All the requisite material for Neutral & Delta Bus formation required for charging of complete bank of 765KV class 1-ph Transformer/Reactor units shall be made available at the concerned sites before receipt of the Transformer/Reactor units at site
		8.3.23 The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub Contractor
		8.3.24 Contractor/sub-vendor, who has more than one contract running concurrently for supply of material of same design and specification from the same factory, may propose to offer material in a single lot. No deduction from payments on account of call combination shall be made to the Contractor. However, POWERGRID reserves the right to carry out call combination as per requirement and decision of POWERGRID shall be final in this regard
		8.3.25 Unless specified otherwise, inspection shall be made at the place of manufacturer prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>8.3.26 Should any item being supplied be found not to comply with the supplied design, it shall be liable to rejection. No item once rejected shall be resubmitted for inspection, except in cases where the Employer or his authorized representative considers that the defects can be rectified. All rejected material shall be disposed-off/destroyed under intimation to Employer QA&I representative as per laid down procedures.
8.3.27 The specified grade and quality of material from approved source shall be used by the Contractor. To ascertain the quality of material used, the inspector may at his discretion get the material tested at an approved laboratory.</td></tr>
<tr><td>5.</td><td>Clause no. 9.2</td><td>The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within the years specified below from the date of NOA. In case the test reports are of the test conducted earlier than the years specified below from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer:-

<table>
<tr><th>S. No.</th><th>Name of Equipment</th><th>Validity of type test(in years)</th></tr>
<tr><td>1</td><td>Power Transformer</td><td>5</td></tr>
<tr><td>2</td><td>LT Transformer</td><td>5</td></tr>
<tr><td>3</td><td>Shunt Reactor</td><td>5</td></tr>
<tr><td>4</td><td>OLTC</td><td>10</td></tr>
<tr><td>5</td><td>Bushing of Power Transformers/Reactors</td><td>7</td></tr>
<tr><td>6</td><td>Fittings and accessories for Power transformers & Reactors</td><td>10</td></tr>
<tr><td>7</td><td>Circuit Breaker</td><td>10</td></tr>
<tr><td>8</td><td>Isolator</td><td>10</td></tr>
<tr><td>9</td><td>Lighting Arrester</td><td>10</td></tr>
<tr><td>10</td><td>Wave Trap</td><td>10</td></tr>
<tr><td>11</td><td>Instrument transformer</td><td>10</td></tr>
<tr><td>12</td><td>GIS & Hybrid GIS</td><td>15</td></tr>
<tr><td>13</td><td>LT Switchgear</td><td>10</td></tr>
<tr><td>14</td><td>Cable and associated accessories</td><td>10</td></tr>
<tr><td>15</td><td>Relays</td><td>7</td></tr>
<tr><td>16</td><td>Capacitors</td><td>10</td></tr>
<tr><td>17</td><td>Battery and Battery charger</td><td>10</td></tr>
<tr><td>18</td><td>Conductor & Earth wire</td><td>10</td></tr>
<tr><td>19</td><td>Insulators (Porcelain/Glass)</td><td>10</td></tr>
<tr><td>20</td><td>Composite Insulators</td><td>5</td></tr>
<tr><td>21</td><td>PLCC</td><td>5</td></tr>
</table>

Note:- For all other equipment’s validity of type test shall be 10 years from date of NOA.
Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.</td></tr>
<tr><td>6.</td><td>Clause No.12.3.6 S.No.4</td><td>
<table>
<tr><td>S.No.</td><td>PIPE LINE</td><td>Base colour</td><td>Band colour</td></tr>
<tr><td>4</td><td>Pylon support pipes</td><td>BLACK</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>7.</td><td>Clause No. 14.4</td><td>CCTV system for Construction Monitoring for Substation/STATCOM Packages – To be provided by the contractor</td></tr>
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<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>
The scope of work shall include “Establishment of CCTV System for Construction Monitoring” of entire switchyard (herein after called CCTV). The contractor shall establish CCTV, atleast 5 days prior to commencement of Construction activities at site. CCTV system shall comprise of PTZ cameras alongwith associated accessories (such as tubular poles, NVR , 6 port POE Switch, 9U Rack -Floor or wall mounted, Cat 6 cable, Power Cabling, Clamps & Connectors, etc. as per requirement) as per details mentioned below :
<table>
<tr><th>S. No.</th><th>Switchyard Type</th><th>Qty of PTZ Cameras</th></tr>
<tr><td></td><td>BOQ for PTZ cameras for CCTV system</td><td></td></tr>
<tr><td>1</td><td>765kV Switchyard (New)</td><td>4 Nos.</td></tr>
<tr><td>2</td><td>765kV Switchyard (Extn)</td><td>2 Nos.</td></tr>
<tr><td>3</td><td>400kV Switchyard (New/Extn)</td><td>2 Nos.</td></tr>
<tr><td>4</td><td>220kV Switchyard (New/Extn)</td><td>2 Nos.</td></tr>
<tr><td>5</td><td>132kV Switchyard (New/Extn)</td><td>1 No.</td></tr>
<tr><td>6</td><td>STATCOM yard</td><td>1 No.</td></tr>
</table>
Above equipment's shall be supplied as per technical specifications attached as Annexure-N. Power Supply arrangement including associated cabling works for above CCTV is to be arranged by the contractor. Further, UPS (including batteries) with minimum 3 hours of backup to ensure continuous working of CCTV system in case of power failure shall also be arranged by the contractor. Internet connectivity required for uploading CCTV feed to the portal/application shall be provided by POWERGRID.

Location of PTZ cameras shall be finalised in consultation with POWERGRID site In-charge. Further, during construction stage if any obstructions/constraints is faced in view of installed cameras, location of cameras shall be suitably modified by the contractor in consultation with POWERGRID site In-charge.

Upon completion of the project i.e. issuance of TOC, aforesaid CCTV system (along with all accessories) shall be dismantled and taken back by the contractor. However, all recordings shall be handed over to POWERGRID site.

The cost for establishing the aforesaid CCTV system is deemed to be included in the overall cost of the project and accordingly no later claims shall be entertained on this account
</td></tr>
<tr><td>8.</td><td>Clause no 17.11.iv)</td><td>iv) Pull out Strength Test.</td></tr>
<tr><td>9.</td><td>Clause No 24.1</td><td>Technical requirements for 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment*:
A) Circuit Breaker
(i) The manufacturer(s) whose 765/400/220/132kV* Circuit Breaker(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class Circuit Breaker(s), which are in satisfactory operation# for atleast two (2) years as on the date of NOA.

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered Circuit Breaker and not meeting the requirement stipulated in (i) above, can also be considered provided that</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		a) 715/345/220/132kV* or higher Voltage class Circuit Breaker(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA. b) In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two (2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered Circuit Breaker(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the Circuit Breaker(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor. **B) Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)** (i) The manufacturer whose 765/400/220/132kV* equipment(s) are offered, must have manufactured, type tested (as per IS/IEC or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA. OR (ii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) and not meeting the requirement stipulated in (i) above, can also be considered provided that: a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA b) Manufacturer has manufactured, type tested (as per IS/IEC or equivalent standard) and supplied equipment(s) of 345kV or above voltage class (applicable for 765kV* Equipment)/220kV or above voltage class (applicable for 400kV* equipment) /132kV or above voltage class (applicable for 220kV* equipment) / 66kV or higher voltage class (applicable for 132kV* equipment), which are in satisfactory operation# for at least two (2) years as on the date of NOA. c) Warranty obligations for additional warranty of two (2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipment(s)* for the additional warranty period in addition to the contract Performance guarantee to be submitted by the contractor. OR (iii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) based on technological support of a parent company or collaborator and not meeting the requirement stipulated in (i) above, can also be considered provided that: a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA. b) The parent company or collaborator meets the qualifying requirements stipulated under (i) given above.

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		A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply the 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment(s)* in India, shall be submitted. c) The parent company/collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor Legends: * : voltage class of respective equipment as applicable. # : satisfactory operation means certificate issued by the Employer/Utility certifying the operation without any adverse remark. NOA: Notification of Award
10.	Clause No 24.2	**Technical Requirement for 765kV class Transformer** (i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA, and the same transformer (s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA. b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted. c) the collaborator shall furnish performance guarantee for an amount of 10**%** of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor
11.	Clause No 24.3	**Technical Requirement for 765kV class Reactor** (i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Reactor of at least 110 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 36.7 MVAR and the same Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA. OR The Manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA and the bidder should have designed, manufactured, tested & supplied 345 kV or higher voltage class one (1) number 3-phase Reactor of at least 50 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 16.7 MVAR and the same Transformer(s) & Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) 715 kV or higher voltage class either One (1) no. 1-phase Reactor of at least 80 MVAR capacity or One (1) no. 1-phase Transformer of at least 166 MVA capacity must have been manufactured in the above Indian works based on technological support of collaborator,

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.

c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor</td></tr>
<tr><td>12.</td><td>Clause No 24.4</td><td>Technical Requirement for 400kV, 220kV, 132kV class Transformer

(i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:

<table>
<tr><td>345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA</td><td>applicable for supply of 400kV class Transformer</td></tr>
<tr><td>220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA</td><td>applicable for supply of 220kV class Transformer</td></tr>
<tr><td>commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA</td><td>applicable for supply of 132kV class Transformer</td></tr>
</table>
These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

a) 220kV (applicable for supply of 400kV class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kVclass Transformer)or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV/220kV/132kV* transformer in India, shall be submitted.

c) The collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</td></tr>
<tr><td>13.</td><td>Clause No 24.5</td><td>Technical Requirement for 400kV, 220kV and 132kV class Reactor

(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested & supplied Reactor as per table below:

<table>
<tr><td>345kVor above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt</td><td>applicable for supply of 400kV class Reactors</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Reactors, each having capacity of at least 16.7 MVAR</td><td></td></tr>
<tr><td>220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR</td><td>applicable for supply of 220kV class Reactors</td></tr>
<tr><td>132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR</td><td>applicable for supply of 132kV class Reactors</td></tr>
</table>
These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.

c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor
</td></tr>
<tr><td>14.</td><td>Clause No 24.6</td><td>Technical Requirement for 400 kV Grade XLPE Power Cables

(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.

OR

b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
15.	**Clause No 24.7**	**Technical Requirement for 220KV,132kV,110kV Grade XLPE Power Cables** (i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/132kV/110kV* or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/132kV/110kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA. OR b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/132kV/110kV* or higher grade XLPE insulated Cable as on the date of NOA. Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor
16.	Clause No 24.15	**Technical Requirements for LT Transformer** (i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 315kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that At least 33kV class of 315kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA. Note In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of **10%** of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.
17.	Clause no 24.16	**Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)** (i) The manufacturer whose Composite Long rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for at least two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA. b) Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.
18.	Clause No. 24.20	**Technical Requirement for 400kV GIS Equipment** (i) The manufacturer whose 400kV GIS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) Atleast one no. 345kV or above voltage class GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above CB bay (as per IEC or equivalent standard) as on the date of NOA. b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV or above voltage level GIS equipment in India, shall be submitted. **c)** The Collaborator(s) shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder. Note :- (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable.
19.	New Clause Clause No. 24.21	**Technical Requirement for 220/132/66 kV* level GIS/Hybrid GIS/MTS Equipment:** (i) The manufacturer whose 220/132/66 kV* level GIS/Hybrid GIS/MTS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 220/110/66kV* or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that a) Atleast one no. 220/110/66kV* or above voltage level GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above GIS bay (as per IEC or equivalent standard) as on the date of NOA. b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 220/110/66*kV or above voltage level GIS equipment in India shall be submitted. **c)** The Collaborator(s) shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder. **Note:**

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>
1. (*) voltage class of respective equipment as applicable

2. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear.

3. Experience with combination of GIS CB Bay/Hybrid GIS CB Bay/MTS CB Bay is also acceptable if supply of only Hybrid/MTS equipment is envisaged. Hybrid GIS means outdoor SF6 Gas insulated switchgear connected to outdoor Air insulated bus-bar System (AIS bus-bars System), MTS means outdoor SF6 Gas insulated Mixed Technology Switchgear connected to outdoor AIS bus bar system.

4. (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable
</td></tr>
<tr><td>20.</td><td>New Clause 27.0</td><td>
The technical parameters for 36kV & 12kV Horn gap fuse
1. 36kV Horn Gap Fuse
<table>
<tr><td>1.</td><td>Rated voltage</td><td>33 kV</td></tr>
<tr><td>2.</td><td>Maximum Continuous voltage</td><td>36 kV</td></tr>
<tr><td>3.</td><td>Rated current</td><td>50 Amps (min)</td></tr>
<tr><td>4.</td><td>Lighting Impulse voltage withstand</td><td>170 KV (Between Live and earth)
195 KV (Across open terminals)</td></tr>
<tr><td>5.</td><td>One minute Power frequency voltage withstand (Dry and Wet)</td><td>70 KV (Between Live and earth)
80 KV (Across open terminals)</td></tr>
<tr><td>6.</td><td>Creepage</td><td>900mm</td></tr>
</table>
2. 12kV Horn Gap Fuse
<table>
<tr><td>1.</td><td>Rated voltage</td><td>11 kV</td></tr>
<tr><td>2.</td><td>Maximum Continuous voltage</td><td>12 kV</td></tr>
<tr><td>3.</td><td>Rated current</td><td>50 Amps (min)</td></tr>
<tr><td>4.</td><td>Lighting Impulse voltage withstand</td><td>75 KV (Between Live and earth)
85 KV (Across open terminals)</td></tr>
<tr><td>5.</td><td>One minute Power frequency voltage withstand (Dry and Wet)</td><td>28 KV (Between Live and earth)
32 KV (Across open terminals)</td></tr>
</table>
Applicable standard: IS9385
</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B.</td><td colspan="2">Section GIS Rev 5A</td></tr>
<tr><td>1.</td><td>New Para under Clause no.1</td><td>For GIS equipment of 52kV and above voltage class envisaged in one substation under a single package, can be supplied from more than one GIS manufacturers, however GIS for each voltage level shall be supplied from a single GIS manufacturer. Further a legally enforceable undertaking (jointly with the each GIS Manufacturer) as per enclosed format to be submitted along with the bidding documents.</td></tr>
<tr><td>2.</td><td>Clause no 5.12</td><td>“The maximum relative SF6 gas leakage rate shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately 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 commissioning during warranty period, the contractor shall rectify the defects to meet the leakage requirement and 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 warranty period.
The maximum relative leakage rate for type tests shall be ≤ 0.1 % per year..”</td></tr>
<tr><td>3.</td><td>Clause no 5. 24</td><td>“The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.”</td></tr>
<tr><td>4.</td><td>Clause no 5.27</td><td>Suitable portable scissor lift (as specified in BPS) for GIS shall be provided for access of distant portion of GIS installation.</td></tr>
<tr><td>5.</td><td>Clause no. 5.31</td><td>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</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		Operating System: i) Low operating pressure ii)Loss of operating power iii)Loss of control supply iv) Pole Discordance.
6.	New Clause no. 5.39.8	Reference Guidelines for GIS Grounding shall be as per **Annexure-12 (Attached at Annexure-S10)**
7.	Clause no. 5.40	Adequate number of UHF sensors shall be provided in the offered GIS of voltage level 220kV and above for detection of Partial discharge (of 5pC and above) as per IEC 60270. The number and location of these sensors……..in close proximity to VT compartments. However, adequacy of number of sensors……. to complete the technical requirement. The calibration and frequency response…….couplers meeting this requirement.
8.	Clause no. 5.41	"*GIS manufacturer as per their design shall preferably use maximum **Fifteen** standard straight horizontal outdoor bus duct lengths for entire GIS installation to optimize the spare requirement."*
9.	New Clause no. 5.41(10)	The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule.
10.	New Para added under Clause no. 5.43.2	The gas density monitoring devices shall have IP rating of IP65 or better and Suitable canopy shall be provided to prevent ingress of rain water for outdoor application.
11.	Clause no. 6.8.2	The CSD shall be provided in following circuit breakers: a) 765kV • Main and Tie bay for Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay b) 400kV • Main and Tie bay for 765/400kV & 400/220kV Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay c) 220 & 132kV • Bay for operation of Shunt reactor The requirement of CSD shall be explicitly specified in price schedule.
12.	New Clause 6.8.3 (n)	For Circuit breaker with CSD controlling a Transformer following is applicable "The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations".
13.	New Clause no. 10.1.3(n)	For 400kV & above voltage class GIS bay module, CT cores shall be duly distributed on both side of circuit breaker. For 220 kV and below voltage level GIS bay module, CT on one side of the circuit breaker is also acceptable.
14.	New Clause no. 15.2.14	All 765kV & 400kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD by using a suitable selector switch irrespective of whether circuit breakers to be supplied are envisaged along with CSD or not as per bid price schedules.
15.	Clause no. 17.1	*"For erection & maintenance of largest/heaviest GIS component/assembly, one number of EOT Crane of suitable capacity shall be provided for GIS Hall. The crane shall consist of all special requirements for erection & maintenance of GIS equipment."* *On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued.*
16.	Clause no 17.2	Deleted
17.	Clause no 17.3	Deleted
18.	New Para added under	During detailed engineering, the type test reports of GIS equipment of the parent company/subsidiary company/group company shall also be acceptable provided that the design of offered GIS is same as that of type tested GIS equipment.

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td>Clause no. 20</td><td></td></tr>
<tr><td>19.</td><td>Clause no 20, Sl. no. 14 of Table</td><td>
<table>
<tr><td>14</td><td>Reactor current switching test for Inductive Current switching capability as per IEC 62271-110. Further, the manufacturer whose circuit breakers tested with smaller current w.r.t current limits specified for Reactor current switching test duty-2, 3 & 4 in IEC 62271-110 shall also be acceptable.</td></tr>
</table>
</td></tr>
<tr><td>20.</td><td>Clause no 24.12</td><td>Deleted</td></tr>
<tr><td>21.</td><td>Annexure-1
S.No. 20 (i)</td><td>
<table>
<tr><th>Parameter</th><th>765kV system</th><th>400kV system</th><th>220kV system</th><th>132 kV system</th></tr>
<tr><td>Pre-insertion resistor requirement</td><td>As per BPS</td><td>As per BPS</td><td>NA</td><td>NA</td></tr>
<tr><td>Rating (ohms)</td><td>Approx. 450 with tolerance as applicable</td><td>Approx. 400 with tolerance as applicable</td><td>NA</td><td>NA</td></tr>
</table>
</td></tr>
<tr><td>22.</td><td>Clause no 25 of Section GIS Rev 5A</td><td>25. ON SITE TESTING
After the GIS Switchgear has been fully installed at site and SF6 gas filled at rated filling density, the complete assembly shall be subjected to the site tests as per IEC-62271-203 and POWERGRID Asset Management Controlled Document No: D-3-01-09-01-02.
25.1 Deleted
25.2 Deleted.
25.3. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b), Annexure-C of IEC 62271-203 during the AC voltage test and a repeat test is performed due to this failure, then the repeat test shall be carried out at Specified voltage.
25.4. Deleted.
25.5. Method statement/ procedure of ON SITE high voltage testing, PD measurement and test shall be submitted by contractor in advance</td></tr>
<tr><td>23.</td><td>New Para under Clause no 26.</td><td>Requirement for Mandatory spares for GIS
a. Any equipment which is not supplied as main equipment or part of main equipment, mandatory spare for that is not applicable.
b. It is recognized that the GIS manufacturer may have standardized the GIS design/equipment rating based on the manufacturer’s standard practice. Alternate proposals, offering higher rating equipment (without additional cost implication), will also be considered provided such equipment meets the specified minimum designs rating, standard and performance requirements.
c. In case contractor offers circuit breaker, dis-connector, current transformer, SF6/Air Bushing etc. under main equipment of higher rating than equipment rating specified in the specifications, the mandatory spare of same higher rating offered by contractor identical to main equipment offered in the package shall be required to be supplied against spares without any cost implication to POWERGRID.</td></tr>
<tr><td>24.</td><td>Annexure-10 Rev-1</td><td>Annexure-10 Rev-1 (Standard Mandatory Spares for Gas Insulated Switchgear) of stands deleted.</td></tr>
<tr><td>25.</td><td>New Annexure-13</td><td>Standard GIS Module Description (Attached at Annexure-S11)</td></tr>
<tr><td>C.</td><td colspan="2">Section Switchgear – CB Rev 11</td></tr>
<tr><td>1.</td><td>Clause no. 2.6 Para 2</td><td>The CSD shall be provided in following circuit breakers:
d) 765kV
• Main and Tie bay for Auto Transformer
• Main and Tie bay of Bus Reactor
• Switchable Line Reactor bay
e) 400kV
• Main and Tie bay for 765/400kV & 400/220kV Auto Transformer
• Main and Tie bay of Bus Reactor
• Switchable Line Reactor bay</td></tr>
</table>

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>f) 220 & 132kV
• Bay for operation of Shunt reactor
The requirement of CSD shall be explicitly specified in price schedule.</td></tr>
<tr><td>2.</td><td>New Clause no. 2.6.1(n)</td><td>For Circuit breaker with CSD controlling a Transformer following is applicable

“The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations”.</td></tr>
<tr><td>3.</td><td>Clause No. 11.4</td><td>Separate cables shall be used for AC, DC-I, DC-II and selected DC. Each control cable shall include minimum 10% spare cores (subject to minimum 1 no. of spare core).</td></tr>
<tr><td>4.</td><td>Clause No. 11.5</td><td>Requirement of Plug-In type connector for Inter-pole cabling is deleted</td></tr>
<tr><td>5.</td><td>Clause No. 11.6</td><td>Vertical run of cables to the operating mechanism box shall be properly supported by providing the perforated closed type galvanized cable tray (Cable tray also to be supplied along with the Circuit Breaker) to be fixed as an integral part of the structures. The load of the cable shall not be transferred to the mechanism box/terminal arrangement in any circumstances. Hanging or loose run of cable is not permitted. The drawing of cable tray including fixing arrangement shall be incorporated in the GA drawing of CB also.</td></tr>
<tr><td>6.</td><td>Clause no 15.2 vii)</td><td>For Low & High temperature type test, Field performance report of CB’s as per IEC 62271-100 revision 2008 (covering amendment-2 in 2017) is also acceptable as valid Type test report.</td></tr>
<tr><td>7.</td><td>Clause No. 16.0 S.No. 20 (i)</td><td>
<table>
<tr><th>Parameter</th><th>765kV system</th><th>400kV system</th><th>220kV system</th><th>132 kV system</th><th>66kV System</th></tr>
<tr><td>Pre-insertion resistor requirement</td><td>As per BPS</td><td>As per BPS</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Rating (ohms)</td><td>Approx. 450 with tolerance as applicable</td><td>Approx. 400 with tolerance as applicable</td><td>NA</td><td>NA</td><td>NA</td></tr>
</table>
</td></tr>
<tr><td>D.</td><td colspan="2">Section: Lighting System Rev 07</td></tr>
<tr><td>1.</td><td>New Para under Clause No. 2.1</td><td>Wherever, Indoor Illumination of building is specified as LS/Lot/SET item in BPS, illumination shall be provided using fixture types as specified in Annexure-I of Section: Lighting System. However, contractor shall submit lighting design calculation for deciding the number of fixtures in each building/room. Following Average lux (at working plane of height 1.2Mtrs from floor level) levels to be maintained for design of illumination system:
<table>
<tr><td>Sl.No.</td><td>Building/Room Type</td><td>Average Lux Level to be maintained</td></tr>
<tr><td>1</td><td>Control Room /Station-In charge Room /Administrative Room/Conference Room / Switchyard Panel Room/ GIS Relay Panel Room</td><td>300 Lux</td></tr>
<tr><td>2</td><td>Electronic Test Lab</td><td>250 Lux</td></tr>
<tr><td>3</td><td>GIS Hall/ Battery Room/ACDC & DCDB Room</td><td>200 Lux</td></tr>
<tr><td>4</td><td>AHU Room/GIS Store Room/ Pantry /Reception/ FFPH Building</td><td>150 Lux</td></tr>
<tr><td>5</td><td>Corridor/ Toilets</td><td>100 Lux</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>6</td><td>Periphery of the Building</td><td>50 Lux</td></tr>
<tr><td>7</td><td>Any other room/building</td><td>200 Lux</td></tr>
</table>
The minimum lux level to average lux level ratio should not be less than 0.6 (i.e Emin/Eav> 0.6).
The maintenance factor for indoor illumination design shall be considered as 0.8.
All required items /equipment /fixtures/ panels/ receptacles/ switches/ switchboards/ fans etc. for Illumination of Control Room Building, GIS Building, FFPH, SPR, Security Hut etc. (as applicable) are deemed to be included under corresponding LS/Lot/SET item of BPS.</td></tr>
<tr><td>2.</td><td>Clause no 4.2</td><td>AC Emergency Lighting System
The lighting panels of this system will be connected to the 415 V
Emergency lighting distribution board (ELDB) which is fed from diesel
generator during the emergency. This system will be provided in Control Room building, GIS Building, Firefighting pump house, Switchyard Area including DG Set & LT Transformer Area. AC Emergency lighting load will be connected to this system which will be normally ‘ON’. Approximate 25 % of lighting fixtures (distributed over all above areas) shall be connected on AC emergency lighting system.</td></tr>
<tr><td>3.</td><td>New para under Clause no 5.1</td><td>EXTERNAL ELECTRIFICATION WORKS
Para-1
Para-2
Para-3
Townships DB’s shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Gland plate shall be cold rolled sheet steel having thickness not less than 3 mm in all cases. However, in case of termination of single core power cables, gland plate shall be of non-magnetic material of at least 4mm thickness.
Township DB shall be provided with a degree of protection of IP: 55.</td></tr>
<tr><td>4.</td><td>Clause no. 6.2.1(ii)</td><td>All Outdoor Lighting Panels shall be of Sheet steel atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.5 mm thick stainless steel of Grade 304 and shall be dust, weather and vermin proof. Panels shall be of smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.</td></tr>
<tr><td>5.</td><td>Clause no. 6.6(i) (b)</td><td>The outdoor junction boxes shall be complete with conduit knockouts/ threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of Cable glands of required size. The junction boxes shall be provided with 4-way knockouts suitable for street lighting/switchyard lighting terminals suitable for 2 numbers 4C x 16 Sq.mm Al. cable or as per requirement.
All Outdoor Junction boxes shall be of Sheet steel atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.5 mm thick stainless steel of Grade 304. Outdoor Junction Boxes shall be suitable for mounting on columns, structures etc for Outdoor Lighting. The outdoor Junction shall have IP 55 protection.”</td></tr>
<tr><td>6.</td><td>Cl. No. 6.7 (viii)</td><td>Earthing of the poles should be connected to the switchyard main
earth mat wherever it is available, else, the same should be earthed
through 3M long, 40 mm dia, earth electrode.</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>E.</td><td colspan="2">Section: LT Switchgear Rev 05</td></tr>
<tr><td>1.</td><td>Clause no. 1.21.2</td><td>Contractor shall submit type test reports for the Lighting transformers as per IS:2026 for which test conducted once are acceptable (i.e. The requirement of test conducted within last ten years shall not be applicable)</td></tr>
<tr><td>2.</td><td>Clause no. 1.6.1</td><td>MCCB shall in general conform to IS: 13947 Part-2. All MCCB offered shall have Ics = 100% Icu rating.</td></tr>
<tr><td>F.</td><td colspan="2">Section DG Set Rev 05</td></tr>
<tr><td>1.</td><td>New para added under Clause no. 7.1(a)</td><td>Alternatively, AMF Panel for DG Set may be installed outside the acoustic enclosure near the DG Set. In such cases, AMF panel with or without additional enclosure shall meet IP-55 degree of protection.</td></tr>
<tr><td>G.</td><td colspan="2">Section Fire Protection Rev 06</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
1.	New para added at Clause no.2.03.00	Fire detection and alarm system shall also be provided in the GIS Hall using beam type smoke detectors to be installed at suitable mounting height, and in the Relay Panel room with ionization/optical type smoke detectors to be installed on the ceiling.
2.	New Clause no.2.01.02	Hydrant posts and Fire extinguishers (CO2 and DCP type) shall also be provided for GIS Building also.
3.	Clause No. 2.04.02 & 10.00.00	Mechanical foam type fire extinguishers wherever specified as 50 litre capacity, conforming to IS:13386, shall be read as 60 litre capacity conforming to IS 16018 Further in case of non-availability of any type of fire extinguisher (i.e. water, CO2, DPC, foam type) of a particular size as specified in BPS or technical specification, next available higher size conforming to IS shall be supplied.
4.	New Clause No. 2.06.05	For new substation, Fire Fighting LT Boards (AC & DC) and Annunciation panels (for FFPH & Control Room Building), shall have number of feeders, annunciation windows, zone-alarm modules (as applicable) required for entire present & specified future scope of the substation.
5.	Clause No.9.01.00 (c) & Appendix-V	Deleted
6.	Appendix-I	Appendix-I (Rev 4) **s**tand replaced by following **Appendix-I (Rev 5)**
7.	Appendix-IV	Revised Appendix-IV Page1 of 13 is replaced by **Annexure-IV rev 01 Page1 of 13.**
H	**Section: Power & Control Cable Rev 06**	
1.	Clause no 1.1.4	Refer **Annexure-S1** for METHODOLOGY FOR SIZING OF CABLES
2.	Clause no 1.2.2	1.2.2. XLPE Power Cables 1.2.2.1. The XLPE (90°C) insulated cables shall be of FRLSH type, C2 category conforming to IS: 7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. All cables shall be of armoured type. For single core cables, the armouring shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables
3.	Clause no 1.2.3	1.2.3. PVC Power Cables 1.2.3.1. The PVC (70°C) insulated power cables shall be of FRLSH type, C2 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. All cables shall be of armoured type. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.
4.	Clause no 1.2.4	1.2.4. PVC Control Cables 1.2.4.1. The PVC (70°C) insulated control cables shall be of FRLSH type C2 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables. All cables shall be of armoured type. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.
5.	Clause No. 4.2	Standard lengths for each size of power and control cables shall be 500/1000 meters. However, to avoid cable wastage and cable jointing at site, non-standard lengths of each size of Power & Control cable may also be acceptable subject to maximum length of 1000meters (+ 5% tolerance)
6.	Clause No. 5	5 TYPE TESTS 5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS. 5.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		5.2.1 Following type tests (on one size in a contract) as per IS: 7098 (Part 1) – 1988 including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V: a) Physical tests for insulation i) Hot set test ii) Shrinkage test b) Physical tests for outer sheath i) Shrinkage test ii) Hot deformation iii) Heat shock test iv) Thermal stability c) Test for Smoke density (as per relevant IS/IEC standard) d) Test for halogen acid gas evolution. e) Flame Retardant on Single cable. f) Flame Retardant on bunched cable. 5.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following tests a) Water absorption (gravimetric) test. b) Ageing in air oven c) Loss of mass in air oven d) Short time current test on power cables of sizes 240 sqmm and above on i) Conductors. ii) Armours. e) Test for armouring wires/strips. f) Oxygen and Temperature Index test. g) Flammability test. h) Smoke density test (on sheathing material) (as per relevant IS/IEC standard)
7.		5.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)- 5.3.1 Following type tests (on one size in a contract) as per IS: 1554 (Part 1) -1988 including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V: a) Physical tests for insulation and outer sheath i) Shrinkage test ii) Hot deformation iii) Heat shock test iv) Thermal stability b) High voltage test (water immersion test only a.c. test as per clause no. 16.3.1). c) Test for Smoke density (as per relevant IS/IEC standard) d) Test for halogen acid gas evolution. e) Flame Retardant on Single cable 5.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following a) High voltage test (water immersion d.c. test as per clause no. 16.3.2 of IS: 1554 (Part 1) - 1988). b) Ageing in air oven. c) Loss of mass in air oven. d) Short time current test on power cables of sizes 240 sqmm and above on i) Conductors. ii) Armours. e) Test for armouring wires/strips. f) Oxygen and Temperature Index test. g) Flammability test h) Flame Retardant on bunched cable

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td>8.</td><td></td><td>Note:- In technical data sheet for 1.1kV XLPE/PVC Power cable & PVC control cable, wherever Type & Category of Cable is written FR & C1 shall be read as FR-LSH & C2, other details kept the same.</td></tr>
<tr><td>I.</td><td colspan="2">Section-Air Conditioning Rev-04</td></tr>
<tr><td>1.</td><td>Clause No. 2.3.2.3</td><td>Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have minimum energy efficiency rating of 4 star as on the date of NOA.</td></tr>
<tr><td>2.</td><td>Clause No. 2.3.3.4</td><td>Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have minimum energy efficiency rating of 4 star as on the date of NOA.</td></tr>
<tr><td>3.</td><td>Clause no. 2.4</td><td>Clause no. 2.4 of Section-Air Conditioning Rev-04 of Technical Specification Void</td></tr>
<tr><td>4.</td><td>New Annexure-S2</td><td><u>Annexure S2</u> – Air Conditioning & Ventilation System for GIS Building</td></tr>
<tr><td>J.</td><td colspan="2">Section Switchyard Erection Rev 10</td></tr>
<tr><td>1.</td><td>New Clause No. 2.5</td><td>Transmission line side insulator string along with hardware for line termination shall be in the scope of substation contractor. The erection of same shall be done by associated TL contactor.</td></tr>
<tr><td>2.</td><td>Clause No. 9.4(j) & (k)</td><td>
<table>
<tr><th>S.No</th><th>Item</th><th>Size</th><th>Material</th></tr>
<tr><td>j)</td><td>Isolator MOM Box</td><td>50X6 mm GS flat & Flexible copper braid</td><td>Galvanised steel and copper braid</td></tr>
<tr><td>k)</td><td>Insulator Guy Arrangement</td><td>75x12mm G.S. flat</td><td>Galvanised Steel</td></tr>
</table>
</td></tr>
<tr><td>3.</td><td>New Clause No. 9.5.8</td><td>For estimation of riser of new substation/switchyard, maximum spacing of Main Earthmat shall be considered as 30 M x 30 M, 24 M x 24 M, 16 M x 16 M & 12 M x 12 M for 765kV, 400kV, 220kV & 132kV switchyard respectively.

For 765/400/220/132kV Substation, maximum spacing of higher voltage level shall be considered for calculating the riser quantiites.

Actual spacing for main earthmat shall be finalized during detailed engineering based on soil resistivity data and payment shall be made as per actual executed quantity at site. However, no cost compensation shall be considered in case of actual spacing of main earthmat finalized during detailed engineering is less than that mentioned above.

For switchyard extensions, main earthmat spacing shall be considered same as that in the existing switchyard.</td></tr>
<tr><td>4.</td><td>Clause no 9.10.3</td><td>Auxiliary earthing mat comprising of minimum 32mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable.</td></tr>
<tr><td>5.</td><td>New Clause No. 10.2</td><td>Following type of conductor for Flexible or Rigid Bus bars/Switchyard Equipment Jumpers/Interconnections shall be provided subject to suitability of conductor as per specified/applicable current ratings:

<table>
<tr><th>Voltage Level</th><th>Conductor / Al .Tube Type</th></tr>
<tr><td>Voltage Level: 765kV</td><td>AAC Bull / 4.5’’ IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 400kV</td><td>ACSR Bersimis / 4.5’’ IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 220kV</td><td>ACSR Moose / 4.0’’ IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 132kV</td><td>ACSR Moose / 3.0’’ IPS Al. Tube</td></tr>
</table>

For substation extension works, suitable clamps & connectors for interconnection with existing buses as per drawings shall be provided by the contractor under present scope.

Conductor type with higher current rating than that specified above shall also be acceptable without any additional price implication.</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		Note: For existing substation, existing conductor configuration may preferably be adopted in extn. S/s package.
6.	New Clause no. 20.1	**Neutral formation for Transformer(s), DELTA formation and making connection arrangement to connect spare unit in place of any unit of the bank without physical shifting and Earthing Arrangement :** For Spare Unit connection to form 3-ph bank of 765kV Class Transformers with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement & Tertiary (DELTA) formation for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below: **i. Neutral Formation including Neutral auxiliary bus and Earthing Arrangement** The contractor shall connect the neutrals of three (3) 1-phase transformers by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare transformer can be disconnected or connected to the three phase banks. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminium tube, conductor, clamps & connectors, earthing materials, support structure, **foundation bolts,** hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor. **ii. Tertiary Delta Formation including Tertiary auxiliary bus(Insulation level 52 kV) .** The contractor shall connect 33kV tertiary of single-phase auto-transformers in DELTA configuration by overhead connection to operate in 3-Ph Bank. The Delta shall be formed by 3" IPS Al tube, which shall be insulated with heat shrinkage insulating sleeve of at least 52kV class and shall be supported by structure mounted bus post insulators at suitable intervals. Jumpers (twin conductors) wherever provided shall also be insulated using suitable insulation tape or sleeve at least 52kV class at site. The minimum phase to phase horizontal spacing for delta formation shall be 1.5meter. All associated materials like bus post insulators, Aluminium tube, conductor, clamps & connectors, support structures, **foundation bolts,** hardware, earthing materials etc. required for tertiary delta formation shall be provided by the contractor. **iii. HV & IV Auxiliary Buses (Applicable for AIS Substation)** Formation of HV & IV auxiliary buses for connection of transformer 3-Phase bank with 1-Phase Spare transformer unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, **foundation bolts,** required for the above-mentioned arrangement shall be provided by the contractor.
7.	New Clause no. 20.2	**Neutral formation for Reactor banks, connection to neutral grounding reactor through 132kV Surge arrester, connection to ground through neutral CTs and connection arrangement to connect spare reactor unit in place of any other units of the bank without physical shifting and Earthing Arrangement :** For Spare Unit connection to 3-ph bank of 765kV Class Reactors with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below: **i. Neutral Formation including Neutral auxiliary bus and Earthing Arrangement** The contractor shall connect the neutrals of three (3) 1-phase reactors by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare reactor can be disconnected or connected to the three phase banks. Neutral Connections of spare unit shall be extended upto the other unit(s) by forming Neutral auxiliary bus. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminum tube, conductor, clamps & connectors, earthing materials, support structure, **foundation bolts,** hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor. Required Insulation level is 145 kV from individual reactor neutral to point of neutral formation. However after neutral formation, the insulation level is 36kV.

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		Connection of each Line reactor bank formed under present scope to Neutral grounding reactor through 132kV Surge Arrester including NGR by passing arrangement is also under present scope. **ii. HV Auxiliary Bus (Applicable for AIS Substation)** Formation of HV auxiliary bus for connection of reactor 3-Phase bank with 1-Phase Spare reactor unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, **foundation bolts,** required for the above-mentioned arrangement shall be provided by the contractor.
8.	New Clause no. 20.3	Supply & Laying of Power, Control Cables & Special Cables (if any) (including all cabling works for spare unit of transformer/reactor) along with accessories for power supply, alarm, trip, control & indication, status and monitoring signals & contacts made available at MB/CMB of Transformers/Reactors upto Control & Relay Panels and BCUs located in the Switchyard Panel Room/Control Room and successful integration of same with Station Control, Protection & SAS System is in the scope of the contractor.
9.	New Clause no. 20.4	3½Cx300 Sq. mm XLPE power cable for oil filtration units of reactors & transformers shall be provided. The cable shall be terminated at 250A receptacle near Reactor & Transformer in the switchyard. XLPE Power cables shall be looped in & out for 250A Power receptacles.
10.	New Clause no. 20.5	Neutral of spare transformer/reactor is to be connected to station grounding system through a jumper/copper flat. This shall be applicable for single phase transformer/reactor wherever spare unit have been provided.
11.	New Clause no. 20.6	Tertiary connections made for tertiary loading of LT Transformer shall be insulated using suitable insulation tape or sleeve of at least 52kV class at site
12.	New Clause no. 20.7	The earthing risers from terminal of Neutral Current Transformer (NCT) of bank of 1-Phase Transformer/Reactor (as applicable) shall be brought down for connection with pipe electrodes by providing suitable insulators mounted on NCT support structure (minimum 2 nos. per support). Necessary provisions on NCT support structure for mounting of insulator shall be provided. These insulators shall deemed to be included in corresponding Erection Hardware item for Transformer/Reactor bay (as applicable) of BPS
13.	New Clause No. 21	Connection arrangement of 765kV equipment's shall be done as per the conceptual drawing (Drawing No. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS, Rev-01) enclosed as **Annexure-S3** of this Section.
14.	New Clause No. 22	For connection to HV bushing of LT Transformer, insulated copper rod/strip of at least 75 sq.mm cross sectional area shall be used.
15.	New annexure	Refer **Annexure-S4** for SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE
K.	**Section CRP Rev 09**	
1.	New Para added under Clause No.5.1	Requirement of Shrouding shall not be applicable to TB's where live parts are concealed.
2.	New para added under Clause no.18.8	Line Differential relays used as both Main –I & Main-II protection of a line, shall be of either different make & model or shall be on different hardware platform.
3.	New para added under	Directional Earth Fault Relay/Function provided shall have Carrier Aided scheme feature which shall be suitable for single phase auto re-closure schemes

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td>Clause no.18.9(s)</td><td></td></tr>
<tr><td>4.</td><td>Clause no. 19.1. (a), (b) and (d)</td><td>a) have single phase & 3 phase reclosing facilities.
b) have a continuously variable dead time range of 0.1-2 seconds.
(d) Auto reclose scheme shall have provision of selection of the following modes:-
i. Single phase.
ii. Three Phase.
iii. Single & three phase.
iv. Non-Auto
The necessary provision in the scheme shall be provided to select the A/R mode from both local and remote</td></tr>
<tr><td>5.</td><td>New Para added under Clause No. 20.4</td><td>Wherever, scope for NGR by passing is envisaged, necessary equipment, wiring etc. required for control & monitoring of 145kV Circuit Breaker for NGR by-passing arrangement shall be under contractor’s scope of work. The same may be located in respective line/reactor protection panel.</td></tr>
<tr><td>6.</td><td>Clause No. 21.1 (e)</td><td>be suitable for individual input from associated CTs with rated CT secondary current of 1 Amp.</td></tr>
<tr><td>7.</td><td>New Clause No. 21.8</td><td>Back-up Impedance protection function shall be provided for 765kV & 400kV sides of 765/400/33kV ICT and for 400kV side of 400kV class ICT. This protection function can be clubbed with any other protection IED’s except of Differential Protection IDC.</td></tr>
<tr><td>8.</td><td>Clause No. 32.9</td><td>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 :
• Potential free contact (Minimum pulse duration of 50 milli seconds.)
• IRIG-B
• RS232C
• SNTP Port (at least 4 ports)
• IEEE 1588 PTP (Applicable only for Process bus automation station)</td></tr>
<tr><td>9.</td><td>New clause 24.3 q)</td><td>In case of extension substation with distributed bus bar protection, if Bay unit is envisaged under scope of the contract, it shall be compatible with the existing central unit. In such case type test for the bay unit once conducted shall hold good. The requirement of type test conducted within last seven years, shall not be applicable for the bay unit.</td></tr>
<tr><td>10.</td><td>Clause no 37. IV Breaker Relay Panel</td><td>BREAKER RELAY PANEL: The breaker relay panel shall consist of the following:
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Qty</th></tr>
<tr><td>1.</td><td>Breaker failure Protection Scheme*</td><td>1no.</td></tr>
<tr><td>2.</td><td>DC supply Supervision relay</td><td>2nos.</td></tr>
<tr><td>3.</td><td>Trip Circuit supervision relays#</td><td>6nos.</td></tr>
<tr><td>4.</td><td>Auto-reclose scheme (##)</td><td>1No.</td></tr>
<tr><td>5.</td><td>Flag relays, aux relays, timers, trip relays as per scheme requirements</td><td>As required</td></tr>
<tr><td>Note-1)</td><td colspan="2"># Trip supervision relays shall be 2 or 6 numbers as per no. of trip coils for each 132KV Circuit breaker</td></tr>
<tr><td>Note- 2)</td><td colspan="2">Equipment/relays to be provided under CB Relay Panel may be accommodated in the Protection Panels to be provided for Transmission Line/Transformer/Reactor as applicable</td></tr>
<tr><td>Note- 3)</td><td colspan="2">* In case of bay extension in existing half diameter, breaker failure relay for main CB / Tie CB shall be supplied only if BFR built-in Bus Bar protection bay unit is not available or Tie CB standalone BFR relay is not available in the existing protection scheme.</td></tr>
<tr><td>Note-3)</td><td colspan="2">## Auto reclose scheme shall also be acceptable as a part of BCU. All Circuit Breaker Relay Panel shall be provided with Auto-reclose function. However, during execution stage Auto-reclose function shall be enabled/ disabled based on requirement</td></tr>
</table></td></tr>
<tr><td>11.</td><td>Clause no 41 (b)</td><td>POWERGRID has standardized binary input/output details, indication details, DR signals & texts, etc. of protection IEDs, SAS HMI Signal List, Protection Panels CT/VT circuit termination detail, Trip Logic etc. and the same shall be used by contractor during detail engineering for preparation of schematics. Standardized documents are attached as Folder APPENDIX-C. Panel nomenclature, terminal blocks identification, as applicable, shall be according to typical detail given at APPENDIX-B (Additional part of TS)</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
L.	**Section SAS Rev 04**	
1.	Typical Architectural Drawing of SAS (Without Process Bus)	TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) stands replaced by **Annexure-S5**
2.	Clause no 1.6	The Sub-station Automation system being offered shall generally conform to provisions of IEC 62351, IEEE1686 and NERC CIP (applicable parts such as CIP 003, CIP-005, and CIP-007) for cyber security. Detailed Cyber Security Requirements, FAT Checklist & SAT Checklist of Control and Protection IEDs & other components are attached as **Annexure-S12 (Annexure-II)-**CyberSecurity_ Requirements_ R0, **Annexure-S13 (Annexure-III)--**FAT_Checklist_R0 & **Annexure-S14 (Annexure-IV)--**SAT_Checklist_R0 respectively
3.	Para 2 under Clause No. 3.3.1	The Substation Automation System shall have communication ports on each gateway (two gateways per station) as follows: (a) Three ports for Remote Control Centres on Secure IEC60870-5-104 protocol. **(b) Two port on IEC 60870-5-104 for Regional System Coordination Centre (RSCC)**
4.	New Para Added Under Clause No.4.1	Redundant Station HMI, Remote HMI (Remote HMI only if mentioned in section project) and Disturbance Recorder Work station: Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement **Technical Specification for Industrial Grade Computers** The minimum hardware configuration of workstation console shall be: • Intel Core i7 processor (8 cores) or better (3Ghz or above) • Minimum 32 GB RAM (DDR4 or better) • Minimum 1 TB SSD • DVD-RW drive • Dual Gigabit Ethernet ports (RJ-45) o Additional Gigabit Ethernet ports shall be provided depending upon the functional requirements. • Input/Output Ports: 2 output ports for Dual Monitor display capability (VGA/HDMI/DVI output ports), 6 USB (minimum 2 USB 3.0 ports), Standard Audio ports (Line in/out & Mic), 2 serial ports, and 1 parallel port. • USB Keyboard and USB Mouse • Speakers for audible alarms (for HMI computers only) • 27 inches LED color monitor (Qty. as per requirement) o Diagonal Viewable size: 27 inches o Resolution: minimum 1920 x 1080 o Color support: 16 million o Input video signal: VGA, DVI, HDMI o 4 way adjustable (tilt, swivel, pivot, height) o On Screen Controls o Anti-glare, anti-reflection and anti-static o Sufficiently wide horizontal & vertical viewing angles **The minimum Software requirement of the workstation console shall be:** • Preinstalled OEM Licensed Microsoft Windows 10/11 Pro 64-bit or latest with media DVD (or) Recovery DVD**.**

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
5.	New Para Added Under Clause No.4.1.5	The bidder shall also provide 2 Nos. managed Ethernet switches with at least 16 copper RJ45 ports on each switch to form managed "Redundant System LAN" for connecting different NTAMC sub-systems devices (SCADA Gateways, VMS, VOIP etc.) as per revised system architecture **(attached as Annexure S5)**. The specification of the switches is enclosed at **Annexure-S6.**
6.	Para 2 Under Clause No.4.1.6	Contractor shall provide 2 nos. Next Generation Firewalls (NGFW); one No. Main & one No. Standby having electrical ethernet interfaces/ports and placed between FOTE & SAS gateways, NTAMC switch etc. at the substation. All ethernet based applications (e.g. PMU, AMR, VOIP, SAS/SCADA etc.) shall be terminated in the firewall ports directly. Each port of firewall shall work as a separate zone. Firewall shall be hardware based with functionality of Block/Allow/drop and IPSec VPN (network encryption). Minimum 16 Nos. of ports/interfaces shall be provided in each firewall (i.e. Main & Standby) Contractor can use either single firewall or multiple firewalls to meet this interfaces requirement, each for main as well as standby firewall. Minimum throughput of firewall shall be 300 Mbps. The Firewall shall be managed/ configured as standalone at present and shall also have compatibility to manage/configure through Centralized Management Console (CMC) remotely in future. OEM Support on 24x7 basis for 7 years shall be provided for all the functions & features of the Firewall. Firewall shall be tested and certified for ISO15408 Common Criteria for least EAL4+. Further, the OEM must certify that it conforms to Secure Product Development Life Cycle requirements as per IEC62443-4-1. The firewall shall generate reports for NERC-CIP Compliance. The specifications for the firewalls are attached at **Annexure-S7.**
7.	Para 3 Under Clause No.4.1.6	The substation routers shall have the following features: - Routing protocols such as OSPF and support for IPv4 and IPv6 **- 8 Ethernet interfaces of 10/100 Mbps** - 2 E1 interfaces - Hot standby operation with a similar router - Support IEEE 802.3u, 802.1p, 802.1Q, 802.1d, 802.1w, - Traffic prioritization for routed IP flows/ports
8.	Bullet no.4 under Clause No. 4.2.1	Each BCU shall be equipped with Local HMI (display) facilities, enabling control of each particular bay from BCU whenever required. The Local HMI facilities shall be accomplished by means of Graphical LCD display embedded into the front panel of the BCU. Display will show the SLD (with device identification number) showing status of bay switching equipment (such as circuit breaker, isolators, earth switches) and enabling issuance of switching controls. Other display type will be multiple displays of analog values readings / reports, displays for controls other than switching, Alarm panel displays, Diagnostic/ online configuration displays etc. **Bay control unit shall have inbuilt metering CVT supervision function. It shall have feature to give alarm in case of CVT/PT metering core fuse fail.**
9.	Clause 4.2.2 New bullet	Bay Control Units for Main System and Auxiliary system at a station shall be classified as below based on it's application and Contractor shall supply following types of BCU applicable under the subject package: Bay control Unit (IED) of Main System (a). Main Bay BCU (b). Tie Bay BCU (c). Switchable Line Reactor Bay BCU Bay control Unit (IED) of Auxiliary System (a) Auxiliary BCU
10.	Clause no. 8.2	*The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system including Control Relay Protection (CRP) for approval based on the standard SAS/CRP FAT procedure of POWERGRID.* ***The Standard SAS FAT format & procedure is provided at Appendix-II (revised)& the Standard CRP FAT format & procedure is provided at Appendix-III (Additional part of TS) for reference guideline.*** *For the individual bay level IED's applicable type test certificates shall be submitted*
11.	New Clause 15.4	Mandatory spares: a. Mandatory Spares for Substation Automation shall be supplied as per BPS. b. The offered "Bay control Unit (IED) of Main System" as spare, shall be sufficient to replace all types of Bay control Units supplied under Main system without addition of any hardware/module etc.

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>Further any additional I/O module and/or hardware supplied under Main system to meet the functional requirement of Bay control Unit in any bay, shall be considered part of Bay control Unit (IED) of Main System.
The offered “Bay control Unit (IED) of Auxiliary System” as spare, shall be sufficient to replace all types of Auxiliary BCU supplied under Auxiliary system without addition of any hardware/module etc.

Further any additional I/O module and/or hardware supplied under Auxiliary system to meet the functional requirement of Bay control Unit shall be considered part of Bay control Unit (IED) of Auxiliary System</td></tr>
<tr><td>12.</td><td>Clause No. 16.0 (v)</td><td><u>LIST OF EQUIPMENTS</u>

v) Two nos. Disturbance Recorder/Engineering Workstation where at least one workstation shall have Linux based operating system.</td></tr>
<tr><td>M.</td><td colspan="2">Section PLCC Rev 05</td></tr>
<tr><td>1.</td><td>New Clause No. 6.12.4</td><td>For 765 kV Wave Trap, cantilever strength of BPIs used for Wave Trap shall be 10 kN.</td></tr>
<tr><td>2.</td><td>New Clause no. 10.4.13</td><td>All protection couplers (Analog protection coupler, digital protection coupler) shall be equipped with direct reading type counter facility for all the codes (Tx & Rx).</td></tr>
<tr><td>3.</td><td>New Clause no.10.5</td><td>Digital protection coupler (DPC) shall be used as one of the two tele-protection channel on the lines between the stations having Optical Fiber link alongwith SDH Equipment. Specification of digital protection coupler is enclosed as <u>Annexure-S8.</u> The DPC can be housed either in offered Control & Protection Panel / PLCC Panel or in separate panel. Generally SDH Equipment are placed in communication room of Control room where as DPC is placed in panel room. The connection between SDH equipment and each DPC shall be through Optical fiber. Necessary cables, converter(s) for converting E1 signal to optical fiber at both ends (at Panel Room as well as at Control room) along with FODP shall be in the scope of the contractor. Further sharing of additional spare ports of converter for DPC placed in other Panel Room or in same Panel Room is also permitted. Necessary optical fiber for interconnection of DPC is to be provided by the contractor. Further any copper wiring for ensuring the protection signaling/data/speech shall be in the scope of the contractor.</td></tr>
<tr><td>N.</td><td colspan="2">VISUAL MONITORING SYSTEM (if specified in BPS)</td></tr>
<tr><td>1.</td><td></td><td>Technical Specification for Visual Monitoring System for watch and ward of substation premises is attached at <u>Annexure-S9</u></td></tr>
<tr><td>O.</td><td colspan="2">Section –400KV Transformer Rev 13</td></tr>
<tr><td>1.</td><td>Clause no 4</td><td>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 respective values as per Table-2 of IEEEC57.104-2019, which are as detailed below

<table>
<tr><th>Fault GAS</th><th>O2/N2 Ratio <u>≤</u>0.2</th><th>O2/N2 Ratio >0.2</th></tr>
<tr><td>Hydrogen (H2)</td><td>200</td><td>90</td></tr>
<tr><td>Methane (CH4)</td><td>150</td><td>50</td></tr>
<tr><td>Ethene (C2H6)</td><td>175</td><td>40</td></tr>
<tr><td>Ethylene (C2H4)</td><td>100</td><td>100</td></tr>
<tr><td>Acetylene (C2H2)</td><td>02</td><td>07</td></tr>
<tr><td>Carbon Monoxide (CO)</td><td>1100</td><td>600</td></tr>
<tr><td>Carbon dioxide (CO2)</td><td>12500</td><td>7000</td></tr>
</table>
If fault gases except CO and CO2 are well below the limit as specified above during warrantee period, furan test may be carried out to ascertain the degree of degradation of the transformer paper insulation. Based on measured furan values CO & CO2 levels may be re-evaluated
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.</td></tr>
<tr><td>2.</td><td>Clause no 6.2.6</td><td>The transformer shall be provided with a suitable diameter pipe flange, gate valve, bolted blanking plate and gasket shall be fitted at the highest point of the transformer for maintaining vacuum in the tank.</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
3.	New Clause no 6.6.6	Buchholz Relay Pipe support (if required) shall be provided from ground to avoid transfer of undue vibration to Buchholz Relay from pump or fans connected with transformer, resulting in maloperation
4.	Clause No. 6.5.1	Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. 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. Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay. **Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and socket with cable at site is not acceptable.**
5.	Clause no 8.2.6	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 bulk 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 flexi bag / stainless steel tanker. The 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.
6.	Clause no 9.1	**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. Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 μm; 130 particle/100 ml with size ≥ 15 μm.
7.	Clause no 10.5	**Deleted**
8.	Clause no 11	**Neutral Formation and Earthing Arrangement** (if specified in BPS)
9.	New Clause no 12.6.1.5	Fire protection operated signal shall be included in the control circuit of Auxiliary power supply distribution scheme to disconnect the power supply to IMB/CCC and associated instrument/devices of CMB to restrict further exaggeration of fire.
10.	New Clause no 12.6.2.4	Fire protection operated signal shall be included in the control circuit of Auxiliary power supply distribution scheme to disconnect the power supply to associated instrument/devices to restrict further exaggeration of fire.
11.	Clause no 13.1	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 covered cable tray or 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.
12.	Clause no 17.1	Current transformers shall comply with IS 2705/ IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).
13.	Annexure-H	**ANNEXURE - H** **1.1 KV GRADE POWER & CONTROL CABLES** **…** **…** **STANDARD TECHNICAL DATA SHEET (1.1kV GRADE XLPE POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)** **STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC POWER CABLES)**

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC CONTROL CABLES)
– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</td></tr>
<tr><td>14.</td><td>New para added under Annexure-E</td><td>Painting Procedure

For coastal area reactor (external surface) painting shall be of C5 type as per ISO 12944-5 with total DFT 320 µm (minimum).</td></tr>
<tr><td>P.</td><td colspan="2">Section 400kV Shunt Reactor Rev. 11</td></tr>
<tr><td>1.</td><td>Clause no. 5</td><td>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 respective values as per Table-2 of IEEEC57.104-2019, which are as detailed below

<table><tr><th>Fault GAS</th><th>O2/N2 Ratio ≤0.2</th><th>O2/N2 Ratio >0.2</th></tr><tr><td>Hydrogen (H2)</td><td>200</td><td>90</td></tr><tr><td>Methane (CH4)</td><td>150</td><td>50</td></tr><tr><td>Ethene (C2H6)</td><td>175</td><td>40</td></tr><tr><td>Ethylene (C2H4)</td><td>100</td><td>100</td></tr><tr><td>Acetylene (C2H2)</td><td>02</td><td>07</td></tr><tr><td>Carbon Monoxide (CO)</td><td>1100</td><td>600</td></tr><tr><td>Carbon dioxide (CO2)</td><td>12500</td><td>7000</td></tr></table>If fault gases except CO and CO2 are well below the limit as specified above during warrantee period, furan test may be carried out to ascertain the degree of degradation of the transformer paper insulation. Based on measured furan values CO & CO2 levels may be re-evaluated.
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.
The moisture content goes above 12 ppm at any temperature during operation including full load</td></tr>
<tr><td>2.</td><td>Clause No. 7.2.7</td><td>The Reactor shall be provided with a 100 mm nominal diameter Gate valve and bolted blanking plate, gasket and shall be fitted at the highest point of the Reactor for maintaining vacuum in the tank</td></tr>
<tr><td>3.</td><td>Clause No. 7.5.1</td><td>Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture.
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.

Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.

Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and socket with cable at site is not acceptable.</td></tr>
<tr><td>4.</td><td>Clause No. 7.6.6</td><td>Buchholz Relay Pipe support (if required) shall be provided from ground to avoid transfer of undue vibration to Buchholz Relay from pump or fans connected with reactor, resulting in maloperation</td></tr>
<tr><td>5.</td><td>Clause no 7.14.4</td><td>Each Reactor unit should have provision for earthing and connected to grounding mat when not in service. For this purpose, line Terminals shall also be earthed through neutral by flexible copper connection. Contractor shall provide suitable arrangement for the above. 1.1kV Grade PVC FRLSH 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.</td></tr>
<tr><td>6.</td><td>Clause no 9.2.6</td><td>Transportation of Oil The insulating oil for the Reactor 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 reactor due to delay</td></tr>
</table>

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>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 flexi bag / stainless steel tanker. The 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.</td></tr>
<tr><td>7.</td><td>Clause no 11.14</td><td>Tan delta at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP,RIP & RIS) at reactor manufacturing works / bushing manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.</td></tr>
<tr><td>8.</td><td>Clause no 15.1</td><td>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 covered cable tray or 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).</td></tr>
<tr><td>9.</td><td>Clause no 16.17</td><td>Fire protection operated signal shall be included in the control circuit of Auxiliary power supply distribution scheme to disconnect the power supply to IMB/CCC and associated instrument/devices of CMB to restrict further exaggeration of fire.</td></tr>
<tr><td>10.</td><td>Clause no 18.1</td><td>Current transformers shall comply with IS 2705/ IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).</td></tr>
<tr><td>11.</td><td>Clause no 22.1 xxxii)</td><td>All Cables (Power, control and shielded / twisted pair for 4-20mA cable from Reactor MB, other control cubicle, etc. (as applicable) to CMB (if applicable) shall be under the present scope. Any special cable if required to be included upto employer‟s C&R panel.</td></tr>
<tr><td>12.</td><td>Annexure-A</td><td>Technical Particulars / Parameters of 245kV Shunt Reactor

2.17 b) Chopped Wave Lightning Impulse Withstand Voltage
HV: 1045 kVp</td></tr>
<tr><td>13.</td><td>Annexure-A</td><td>Technical Particulars / Parameters of Neutral Grounding Reactor (NGR)

4.12 Max. temperature rise over ambient temperature of 50øC at rated voltage.

of top oil measured by thermometer: 45

of winding measured by resistance: 50</td></tr>
<tr><td>14.</td><td>Annexure-B</td><td>Test Plan
Test on NGR

<table>
<tr><th colspan="2">Test on NGR</th></tr>
<tr><td>Item</td><td>Test</td></tr>
<tr><td>Measurement of winding resistance</td><td>Routine</td></tr>
<tr><td>Measurement of Impedance by V/I</td><td>Routine</td></tr>
<tr><td>Measurement of insulation resistance</td><td>Routine</td></tr>
<tr><td>Measurement of Capacitance & Tan delta of winding insulation to earth and bushing</td><td>Routine</td></tr>
<tr><td>Lightning impulse test</td><td>Routine</td></tr>
<tr><td>Separate source voltage withstand test</td><td>Routine</td></tr>
<tr><td>Isolation Test</td><td>Routine</td></tr>
<tr><td>Oil leakage test</td><td>Routine</td></tr>
<tr><td>Appearance, construction and dimension check</td><td>Routine</td></tr>
<tr><td>High voltage with stand test on auxiliary equipment and wiring after assembly</td><td>Routine</td></tr>
<tr><td>Tank Vacuum test</td><td>Routine</td></tr>
<tr><td>Tank Pressure test</td><td>Routine</td></tr>
<tr><td>Measurement of vibration at rated continuous current</td><td>Routine</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Measurement of loss</td><td>Routine</td></tr>
<tr><td>Short time current test and measurement of impedance at short time current</td><td>Type</td></tr>
<tr><td>Measurement of acoustic sound / noise level</td><td>Type</td></tr>
<tr><td>Temperature rise test</td><td>Type</td></tr>
</table>
</td></tr>
<tr><td>15.</td><td>Annexure-D</td><td>Sl. nos. (i) and (iv) of Reference Drawings mentioned at Annexure-D stands deleted.</td></tr>
<tr><td>16.</td><td>Annexure-E</td><td>Painting Procedure

For coastal area reactor (external surface) painting shall be of C5 type as per ISO 12944-5 with total DFT 320 µm (minimum).</td></tr>
<tr><td>17.</td><td>Annexure-H</td><td>Technical Parameters of Current Transformers - 420 kV Shunt Reactor On each phase connection & Neutral Grounding Reactor (NGR)
b) Minimum knee point voltage or burden and accuracy class (Neutral side CT)
Core-1 : 200V, PX / PS Class</td></tr>
<tr><td>18.</td><td>Annexure-I</td><td>ANNEXURE - I
1.1 KV GRADE POWER & CONTROL CABLES
…
…
STANDARD TECHNICAL DATA SHEET (1.1kV GRADE XLPE POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC CONTROL CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</td></tr>
<tr><td>19.</td><td>Clause no 9.1</td><td>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.
Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5µm; 130 particle/100 ml with size ≥ 15µm.</td></tr>
<tr><td>Q.</td><td colspan="2">Section- 765kV Auto-transformer Rev 08</td></tr>
<tr><td>1.</td><td>clause no 4</td><td>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 respective values as per Table-2 of IEEEC57.104-2019, which are as detailed below

<table>
<tr><th>Fault GAS</th><th>O2/N2 Ratio ≤0.2</th><th>O2/N2 Ratio >0.2</th></tr>
<tr><td>Hydrogen (H2)</td><td>200</td><td>90</td></tr>
<tr><td>Methane (CH4)</td><td>150</td><td>50</td></tr>
<tr><td>Ethene (C2H6)</td><td>175</td><td>40</td></tr>
<tr><td>Ethylene (C2H4)</td><td>100</td><td>100</td></tr>
<tr><td>Acetylene (C2H2)</td><td>02</td><td>07</td></tr>
<tr><td>Carbon Monoxide (CO)</td><td>1100</td><td>600</td></tr>
<tr><td>Carbon dioxide (CO2)</td><td>12500</td><td>7000</td></tr>
</table>
If fault gases except CO and CO2 are well below the limit as specified above during warrantee period, furan test may be carried out to ascertain the degree of degradation of the transformer paper insulation. Based on measured furan values CO & CO2 levels may be re-evaluated</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		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
2.	Clause 6.5.1	Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. 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. Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay. **Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and socket with cable at site is not acceptable.**
3.	New Clause 6.6.7	Buchholz Relay Pipe support (if required) shall be provided from ground to avoid transfer of undue vibration to Buchholz Relay from pump or fans connected with transformer, resulting in maloperation
4.	Clause no 6.14.4	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 FRLSH 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.
5.	Clause no 8.1	**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. Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5µm; 130 particle/100 ml with size ≥ 15µm.
6.	Clause no 8.2.6	**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 flexi bag / tanker. The flexi bag / Stainless steel 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.
7.	Clause no 10.15	Tan delta at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP,RIP & RIS) at transformer manufacturing works / bushing manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.
8.	New Clause no 13.4.5	Fire protection operated signal shall be included in the control circuit of Auxiliary power supply distribution scheme to disconnect the power supply to IMB/CCC and associated instrument/devices of CMB to restrict further exaggeration of fire.
9.	Clause no 14.1	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 covered cable tray or 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.

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td>10.</td><td>Clause no 19.1</td><td>Current transformers shall comply with IS 2705/ IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).</td></tr>
<tr><td>11.</td><td>New para added under Annexure-E</td><td>Painting Procedure

For coastal area application, transformer (external surface) and outdoor cubicle painting (Except Stainless Steel material) shall be of C5 type as per ISO 12944-5 with total DFT 320 μm (minimum).</td></tr>
<tr><td>12.</td><td>Annexure-H</td><td>ANNEXURE - H
1.1 KV GRADE POWER & CONTROL CABLES
…
…
STANDARD TECHNICAL DATA SHEET (1.1kV GRADE XLPE POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC CONTROL CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</td></tr>
<tr><td>R.</td><td colspan="2">Section-765kV Shunt Reactor, Rev. 08</td></tr>
<tr><td>1.</td><td>Clause no. 5</td><td>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 respective values as per Table-2 of IEEEC57.104-2019, which are as detailed below
<table>
<tr><th>Fault GAS</th><th>O2/N2 Ratio ≤0.2</th><th>O2/N2 Ratio >0.2</th></tr>
<tr><td>Hydrogen (H2)</td><td>200</td><td>90</td></tr>
<tr><td>Methane (CH4)</td><td>150</td><td>50</td></tr>
<tr><td>Ethene (C2H6)</td><td>175</td><td>40</td></tr>
<tr><td>Ethylene (C2H4)</td><td>100</td><td>100</td></tr>
<tr><td>Acetylene (C2H2)</td><td>02</td><td>07</td></tr>
<tr><td>Carbon Monoxide (CO)</td><td>1100</td><td>600</td></tr>
<tr><td>Carbon dioxide (CO2)</td><td>12500</td><td>7000</td></tr>
</table>
If fault gases except CO and CO2 are well below the limit as specified above during warrantee period, furan test may be carried out to ascertain the degree of degradation of the transformer paper insulation. Based on measured furan values CO & CO2 levels may be re-evaluated
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</td></tr>
<tr><td>2.</td><td>Clause no 7.1.11(b)</td><td>Specific area shall not be provided for jacking pad in the foundation as jacking shall be done by laying metal plates size 400 mm x 400 mm x 32 mm (min) thick. One set of metal plates for jacking of Reactor shall be provided by manufacturer.</td></tr>
<tr><td>3.</td><td>Clause no 7.2.7</td><td>The Reactor shall be provided with a 150 mm nominal diameter Gate valve and bolted blanking plate, gasket and shall be fitted at the highest point of the Reactor for maintaining vacuum in the tank</td></tr>
<tr><td>4.</td><td>Clause No. 7.5.1</td><td>Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture.
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.

Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.
Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and</td></tr>
</table>

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 10)
		socket with cable at site is not acceptable.
5.	New Clause no 7.6.6	Buchholz Relay Pipe support (if required) shall be provided from ground to avoid transfer of undue vibration to Buchholz Relay from pump or fans connected with reactor, resulting in maloperation
6.	Clause no 7.14.4	Each Reactor unit should have provision for earthing and connected to grounding mat when not in service. For this purpose, line Terminal shall also be earthed through neutral by flexible copper connection. Contractor shall provide suitable arrangement for the above. 1.1kV Grade PVC FRLSH 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.
7.	Clause no 8.1	**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. Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 μm; 130 particle/100 ml with size ≥ 15 μm.
8.	Clause no 9.2.6	Transportation of Oil The insulating oil for the Reactor 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 reactor 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 flexi bag / tanker. The flexi bag / Stainless steel 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
9.	Clause no 11.16	Tan delta at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP,RIP & RIS) at reactor manufacturing works / bushing manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.
10.	Clause no 15.1	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 covered cable tray or 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.
11.	Clause no 16.18	Fire protection operated signal shall be included in the control circuit of Auxiliary power supply distribution scheme to disconnect the power supply to IMB/CCC and associated instrument/devices of CMB to restrict further exaggeration of fire.
12.	Clause no 17.1.1	All required power & control cables including optical cable, patch chord (if any) upto MB (for 3-Ph unit) or Common MB (for 1-Ph unit) shall be in the scope of contractor. Further, any special cable between MB (for 3-Ph unit) or Common MB (for 1-Ph unit) to switchyard panel room/control room shall be under the present scope.
13.	Clause no 17.1.2	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.
14.	Clause no 18.1	Current transformers shall comply with IS 2705/ IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).

<table>
<tr><th>S.No.</th><th>Clause No.</th><th>Amended As (As per Specific Requirement Rev 10)</th></tr>
<tr><td>15.</td><td>Clause no 22.xxix)</td><td>All Cables (Power, control and shielded / twisted pair for 4-20mA cable from Reactor MB, other control cubicle, etc. (as applicable) to CMB (if applicable) shall be under the present scope. Any special cable if required to be included upto employer’s C&R panel.</td></tr>
<tr><td>16.</td><td>New para added under Annexure-E</td><td>Painting Procedure

For coastal area reactor (external surface) painting shall be of C5 type as per ISO 12944-5 with total DFT 320 µm (minimum).</td></tr>
<tr><td>17.</td><td>Annexure-I</td><td>ANNEXURE - I
1.1 KV GRADE POWER & CONTROL CABLES
…
…
STANDARD TECHNICAL DATA SHEET (1.1kV GRADE XLPE POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC POWER CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

STANDARD TECHNICAL DATA SHEET (1.1kV GRADE PVC CONTROL CABLES) – VOID (Parameters of Standard Technical Data Sheet shall not be referred to)</td></tr>
<tr><td>18.</td><td>Annexure-C</td><td>Sl. nos. (i) and (iii) of Reference Drawings mentioned at Annexure-C stands deleted.</td></tr>
<tr><td>S.</td><td></td><td>BATTEY AND BATTEY CHARGER</td></tr>
<tr><td>1.</td><td>Clause no 1.2.14.2.</td><td><u>List of Factory & Site Tests for Battery</u>

<table>
<tr><th>Sl. No.</th><th>Test</th><th>Factory Tests</th><th>Site Tests</th></tr>
<tr><td>1.</td><td>Physical Verification</td><td></td><td>✓</td></tr>
<tr><td>2.</td><td>C/10 Capacity test on the cell</td><td>✓</td><td>✓</td></tr>
<tr><td>3</td><td>8 Hrs. Charge and 15 minutes discharge test at full rated load</td><td></td><td>✓</td></tr>
</table>
</td></tr>
<tr><td>T.</td><td></td><td>FREQUENTLY ASKED QUESTIONS</td></tr>
<tr><td>1.</td><td></td><td>Frequently Asked Questions attached at Annexure-S15</td></tr>
</table>

Sl. No.	Power System Equipment	Minimum Local Content (%)
1	Power Transformers (up to 765 kV, including Generator Transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (Up to 400kV)	60
6	Resin Insulated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765kV AC-Alternating Current)	60
8	Disconnectors, Isolators (up to 765kV AC)	60
9	Wave Trap (up to 765kV AC)	60
10	Oil Filled Distribution Transformers up to & including 33kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry type Distribution Transformers up to & including 33kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional conductor	60
13	Accessories for conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and accessories	60
15	Optical ground wire (OPGW)- all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and accessories	60
18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33kV	60
20	Control cables including accessories	60
21	XLPE cables up to 220kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Long Rod Insulators with Room temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BFD)	60
32	Power Line Carrier Communication (PLCC) system (up to 800kV)	60
33	Gas Insulated Switchgear (up to 400kV AC)	60
34	Gas Insulated Switchgear (above 400kV AC)	50
35	Surge/Lightning Arrester (up to 765kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6kV to 33kV)	60
38	Ring Main Unit (RMU) (up to 33kV)	60

39	Medium Voltage (MV) GIS panels (up to 33kV)	60
40	Automation and Control system/Supervisory Control and Data Acquisition (SCADA) system in Power system	50
41	Control and Relay panel (including Digital/Numerical relays)	50
42	Electrical motors 0.37kW to 1MW	60
43	Energy meters excluding smart meters	50
44	Control and Power cables and accessories (up to 1.1kV)	60
45	Diesel Generating (DG) set	60
46	DC system (DC Battery & Battery Charger)	60
47	AC and DC Distribution board	60
48	Indoor Air Insulated Switchgear (AIS) up to 33kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxiliary Relays	50
55	Load Break Switch	50
56	Cranes, EOT cranes, gantry crane & chain pulley blocks, etc	60
57	Elevator	60
Fire Protection and Detection system		
58	Motor driven fire water pumps	60
59	Diesel engine driven fire water pumps	60
60	Hydrant system	60
61	High velocity water spray system	60
62	Medium velocity water spray system	60
63	Foam Protection system	60
64	Inert gas flooding system	60
65	Fire tenders	60
66	Portable fire-extinguishers	60

Assessment report from Contractor for proposed sub-vendor along with following enclosures (to the extent available):

1. Proof of MSME certificate (Udhyam registration), if applicable
2. Registration / License of the works
3. Organization chart with name and qualification of key persons
4. List of Plant and Machinery.
5. List of testing equipment with their calibration status.
6. List of Raw material, bought out items with sourcing details
7. List of out-sourced services with sourcing details.
8. List of supply in last three years.
9. Third party approval, if any (viz. ISO, BIS),
10. Pollution clearance wherever applicable
11. Energy Conservation & Efficiency report
    (Applicable to industries having contract load more than 100 KVA)
12. Formats for RM, in process and acceptance testing
13. Type test approvals conducted in last 5 years, if applicable
14. Performance Certificates from customers
15. Photographs of factory, plant and machinery & testing facilities
16. Audit report of the proposer, in case of request for approval of new vendor is submitted by Contractor/Sub-vendor

ANURAG KRISHAN ARORA

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Annexure-G Rev 01

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
A.01	LT Transformer /Power Transformer/ Reactor/ Converter Transformer/ Filter Reactor	MQP/ITP	IV
A.02	Bushing	MQP	IV
A.03	Insulating Oil	POWERGRID TS	III
A.04	Oil storage tank for transformers	MQP	III
A.05	Nitrogen injection-based explosion prevention system	FAT/ITP	III
A.06	Online oil drying system for transformers	POWERGRID TS	II**
A.07	Online DGA and moisture monitoring system	POWERGRID TS	II**
A.08	Flow sensitive conservator isolation valve	POWERGRID TS	II**
A.09	Oil Filtration Machine	MQP	III
B.01	Circuit Breakers	MQP	IV
B.02	Current Transformers	MQP/ITP	IV
B.03	CVT/PT/IVT	MQP	IV
B.04	Isolators	MQP/ITP	IV
B.05	Surge Arrestors	MQP/ITP	III
B.06	Line Trap & Air Core Reactor	MQP/ITP	III
B.07	Point On switching device (CSD) for Circuit Breaker (wherever required)	FAT/ITP	I
C.01	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	ITP	IV
C.02	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	ITP	IV
C.03	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	ITP	IV
C.04	Harmonic Pass filters	ITP	IV
C.05	HT Capacitor	MQP	IV
D.01	Thyristor Valve	FAT/ITP	III
D.02	PLC Capacitors for HVDC	FAT/ITP	III
D.03	Valve Cooling system for HVDC	FAT/ITP	III
D.04	AC/DC Filter Resistors	ITP	III
D.05	DC Current and Voltage measuring device for HVDC	FAT/ITP	III
D.06	Maintenance platform for valve hall	POWERGRID TS	II
D.07	Optical signal column for FSC	FAT/ITP	II
E.01	GIS including spares	MQP/ITP	IV
E.02	Dew Point Meter for GIS	POWERGRID TS	I*
E.03	Portable Partial Discharge monitoring system for GIS	POWERGRID TS	I*

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
E.04	Partial Discharge Monitoring System (Online) for GIS	ITP	III
E.05	PEB Structure and Puf Panels	MQP	III
F.01	Substation Automation system	FAT/MQP	III
F.02	Event Logger	POWERGRID TS	III
F.03	PLCC equipment Viz PLCC Terminal, Carrier equipment, Protection Coupler , Coupling Device but excluding EPABX / HF Cable	MQP	III
F.04	Control & Relay Panels	MQP	III
G.01	EHV Cables	MQP/ITP	III
G.02	Power Cables & Control Cables	MQP	III
G.03	Cable Joints (11 kV and above)	POWERGRID TS	II
G.04	Cable Lugs & Glands / Clamps/Terminations	POWERGRID TS	I
G.05	Distributed Temperature Sensing Instrument (DTS)	POWERGRID TS	II
H.01	LT Switchgear & ACDB/DCDB/MLDB/ELDB	MQP	III
H.02	Battery	POWERGRID TS	II
H.03	Battery Charger	MQP	III
H.04	UPS & Voltage Stabilizer	MQP/FAT	III
H.05	D. G. Set	FAT/ITP	III
H.06	Lighting Panel	POWERGRID TS	II
H.07	Lighting Poles	POWERGRID TS	II
H.08	Lighting Earthwire, Switches / sockets, Conduits, Lamps & fans including exhaust fans	POWERGRID TS	I
H.09	MS/GI /PVC Pipes for cable trenches and lighting	POWERGRID TS	I
H.10	Outdoor Receptacle	POWERGRID TS	I
H.11	Split A.C/window A.C./ precision AC/ Kiosk AC/ Cascade AC/ Tower AC	POWERGRID TS	I
H.12	Occupancy sensors for control of lighting	POWERGRID TS	I
H.13	Solar based street lighting pole including Solar Panel, Inverter, Controller, etc.	POWERGRID TS	III
H.14	Junction Box / Lighting Switch Boards / Bay MB / Portable Flood Light Panel	POWERGRID TS	II
H.15	Lighting transformer	POWERGRID TS	II
H.16	LED Lighting Fixtures	POWERGRID TS/FAT	III
I.01	SF6 gas processing unit, SF6 gas Leakage detector, SF6 gas Analyzer	POWERGRID TS	I*
I.02	SF6 Gas	POWERGRID TS	I
I.03	Spark Gap	FAT/ITP	III
I.04	Time synchronizing Equipment (GPS Clock)	POWERGRID TS	I
I.05	Galvanized Cable trays	POWERGRID TS	II
I.06	Video Monitoring System	FAT/ITP	I
I.07	Public Address System (All Components)	POWERGRID TS	I

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
I.08	Building Management System (All components)	POWERGRID TS	I
I.09	Access Control System (All Components)	POWERGRID TS	I
I.10	Video Display system/ Video Projection system	POWERGRID TS	I
I.11	VESDA (smoke detector)	POWERGRID TS	I
I.12	High Mast Pole	MQP	III
J.01	Aluminium ladder	POWERGRID TS	I
J.02	Hume Pipes	POWERGRID TS	I
J.03	Castle Key	POWERGRID TS	I
J.04	Water Treatment plant (All components).	POWERGRID TS	I
J.05	Furniture	POWERGRID TS	I
J.06	DOL Starter	POWERGRID TS	I
J.07	Oil Sample Bottles and Syringe	POWERGRID TS	I
J.08	Test & Measuring Equipment, T&P	POWERGRID TS	I*
K.01	EOT Crane	POWERGRID TS	II
K.02	Boom Crane/Golf Cart/Platform Truck/Man Lift/ Forklift/ Lifts	POWERGRID TS	II
L.00	Fire Protection System		
L.001	Panels, Hydro pneumatic tank for fire protection system.	POWERGRID TS	III
L.002	Deluge valve, Strainers, MS/GI pipes, Pumps, motors, air compressor, Solenoid and other valves, Diesel Engines	POWERGRID TS	II
L.003	Others	POWERGRID TS	I
M.00	HVAC SYSTEM		
M.001	Air Cooled Chiller	POWERGRID TS	III
M.002	Pump	POWERGRID TS	II
M.003	Air Handling Unit	POWERGRID TS	II
M.004	Fan Filter Unit With Centrifugal Blower	POWERGRID TS	II
M.005	Axial Flow Fan	POWERGRID TS	II
M.006	Main Climate Control Unit (Dehumidifier)	POWERGRID TS	I
M.007	Dampers	POWERGRID TS	II
M.008	Fire Dampers	POWERGRID TS	II
M.009	Pressure Gauge, Thermometers, Other Instruments / Sensors	POWERGRID TS	I
M.010	Grill, Diffuser, Jet Nozzle, Louvers etc	POWERGRID TS	I
M.011	Ducting	POWERGRID TS	III
M.012	M S Pipe	POWERGRID TS	II
M.013	Pipe Insulation Material	POWERGRID TS	I
M.014	Duct Insulation Material	POWERGRID TS	I
M.015	Underdeck Insulation Material	POWERGRID TS	I
M.016	Gate Valve & Non-Return valve	POWERGRID TS	I
M.017	Y Strainer	POWERGRID TS	II
M.018	Ball Valve/ Motorized Butterfly Valve/ Balancing Valve	POWERGRID TS	I

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
M.019	Closed Expansion Tank	POWERGRID TS	II
M.020	Air Separator	POWERGRID TS	I
M.021	MCC /PLC /Electrical Panels	POWERGRID TS	III
M.022	Propeller Fan/ Conduit	POWERGRID TS	II
M.023	Air Filter/ Mixing Valve with Thermostat	POWERGRID TS	I
N.01	SDH Equipment	FAT/ITP	IV
N.02	Termination Equipment Primary/ DI Multiplexer	FAT/ITP	IV
N.03	DACS	FAT/ITP	IV
N.04	Optical Amplifier	FAT/ITP	IV
N.05	FODP including pigtail, Joint Box, FDMS	FAT/ITP	II
N.06	IMPS	FAT/ITP	IV
N.07	Optical bypass switch	FAT/ITP	IV
N.08	Air Purifier	FAT/ITP	I
N.09	Patch cord & connector	FAT/ITP	I
N.10	NMS	FAT/ITP	IV
N.11	OPGW Cable	MQP/ITP/FAT	III
N.12	Hardware Fittings for OPGW cable	MQP/ITP	III
N.13	DCPS	FAT/ITP	III
N.14	Radio Links	FAT/ITP	III
N.15	SMPS based DC Power Supply (DCPS) system	FAT/ITP	III
N.16	WAMS (PMU & Accessories)	FAT/ITP	III
N.17	PUF Shelter	FAT/ITP	III
N.18	Aerial OFC/UGOFC/ADSS/FO Cable	FAT/ITP	III
N.19	DWDM	FAT/ITP	III
N.20	OTN	FAT/ITP	III
N.21	MPLS-TP Equipment	FAT/ITP	III
N.22	L2 Switch	FAT/ITP	III
N.23	IP-MPLS Router	FAT/ITP	III
N.24	HDPE Pipes	POWERGRID TS	II
N.25	Equipment Cabinets	POWERGRID TS	II
N.26	Main Distribution Frame	POWERGRID TS	I
N.27	Telephone system, EPABX, Telephone wires, Telephone sockets	POWERGRID TS	I
N.28	Fiber Optic Cable	MQP	III
N.29	Hardware Fittings for Fiber Optic cable	MQP	III
O.01	Re-rollers of MS/HT Angle Section and galvanized tower parts.	MQP	IV
O.02	Conductor	MQP	IV
O.03	Hardware fittings and Conductor & Earthwire Accessories	MQP	IV
O.04	Earth wire	MQP	IV

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
O.05	Insulator	MQP	IV
O.06	Bolts & Nuts of Gr 8.8 / 8	MQP	IV
O.07	Mono Pole	MQP	IV
O.08	Foundation Bolts and Anchor Bolts	POWERGRID TS	III
O.09	D-shackle/ Hanger / Links and associated Special bolt/nuts	MQP	III
O.10	Span Marker, Obstruction lights and Wind Measuring Equipment	POWERGRID TS	III
O.11	MS ROD rolled by Approved Re-roller of POWERGRID	MQP	III
O.12	MS ROD rolled by Approved steel producers of POWERGRID	POWERGRID TS	I
O.13	Spring Washers & Pack washers	POWERGRID TS	II
O.14	Bolts & Nuts Gr up to 5.6/5	POWERGRID TS	II
O.15	ACD & Barbed wire for ACD/Bird guard	POWERGRID TS	II
O.16	Danger Plate /Phase Plate / Number Plate / Circuit plate	POWERGRID TS	I
O.17	Sub Station Structure (lattice/pipe type)	MQP	III
O.18	Clamps & Connecters (including equipment connectors)	MQP	III
O.19	MS/ GI Flat, rod type, pipe type and other earthing material.	POWERGRID TS	II
O.20	Aluminium Tube & Busbar materials	POWERGRID TS	II
O.21	Pipe Type & Counter Poise Earthing	POWERGRID TS	II
O.22	Chemical and Mechanical Anchor Bolts	POWERGRID TS	I
O.23	Bird Flight Diverter	POWERGRID TS/FAT	II

For Equipment where requirement of MQP is envisaged, ITP/FAT will be followed If sourced from off shore. For items required in S/S or T/L or TELECOM/GA&C , same inspection level as specified shall be followed for all the cases.

*MICC for test and measuring equipment (inspection level I or II) shall be issued only after actual verification/ demonstration of satisfactory performance at site.

** Though level-2 items, CIP/MICC can be issued also on review of TCs and visual inspection of these item.

Annexure- M

MANUFACTURING QUALITY PLAN

	Manufacturers Details (Name, Works Address etc.)	Customer POWERGRID	Vendor's Code:	Item:	Q.P. No. Rev. No. Date:	Valid From: Valid Upto:

Sr. No.	Components / Operations & Description of Test	Type of check	Quantum of Check / Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
A. Section: RAW MATERIAL INSPECTION													
B. Section : IN PROCESS INSPECTION													
C. Section: FINAL TESTING													
D. Section: PACKING & DISPATCH													

		Customer **POWERGRID**	**Vendor's Code:**	**Item:**	**Q.P. No.** **Rev. No.** **Date:**	**Valid From:** **Valid Upto:**

Code 1	Indicates place **where testing is planned** to be performed i.e. Inspection location
A	At Equipment Manufacturer's works
B	At Component Manufacturer's works
C	At Authorized Distributor's place
D	At Independent Lab
E	At Turn Key Contractor's location
F	Not specified

Code 2	Indicates **who has to perform the tests** i.e. Testing Agency
J	The Equipment Manufacturer
K	The Component Manufacturer
L	The Third Party
M	The Turnkey Contractor

Code 3	Indicates **who shall witness** the tests i.e. Witnessing Agency
P	Component Manufacturer itself
Q	Component Manufacturer and Equipment Manufacturer
R	Component Manufacturer, Equipment Manufacturer and Contractor
S	Equipment Manufacturer itself
T	Equipment Manufacturer and Contractor
U	Equipment Manufacturer and/or Contractor and POWERGRID
V	Third Party itself

Code 4	Review of Test Reports/Certificates
W	By Equipment manufacturer during raw material/bought out component Inspection.
X	By Contractor during product/process inspection
Y	By POWERGRID during product/process inspection
Z	By Contractor and/or POWERGRID during product/process inspection

Code 5	Whether specific approval of sub-vendor / Component make is envisaged?
E	Envisaged
	Not Envisaged

Code 6	Whether test records required to be submitted after final inspection for issuance of CIP/MICC
Y	Yes
N	No

I **Outdoor IP Based PTZ Camera:**

S No	Minimum Specifications	
1)	**Salient features:**	
a)	The cameras shall be pure IP based, and the Camera shall be compliant to ONVIF standards.	
b)	The cameras shall have PAN, TILT and ZOOM facilities.	
c)	The cameras must be operative in automatic mode for switching from day mode to night mode depending on the ambient natural light intensity without having to manually operate.	
d)	The cameras shall have IP-66 Protection Class enclosures or better.	
e)	The camera shall be suitable for wall mounting, ceiling mounting, pole mounting and switchyard structure mounting. All accessories needed for the mounting shall be provided.	
f)	Presets: Minimum 64 nos.	
g)	The camera shall have a Motion Detection feature.	
2)	**Camera Interface:**	
a)	The camera communication port shall be interfaced with a Media Converter (Copper to Fiber)/ Ethernet switch to be provided in a junction box.	
3)	**Junction Box**	
a)	The junction box shall accommodate all the necessary equipment such as power converter / LIU / Media converter / Fiber patch cords etc. and shall be of industrial grade type suitable for permanent outdoor use.	
4)	**SPECIFICATIONS & FEATURES**	
a)	**Camera/Optics:**	
	Zoom	30x Optical zoom or better and 12x digital zoom or better
i)	Image sensor	1/2.8" CMOS
ii)	Effective Pixel	(PAL): 1920*1680 or better

iii)	Lens	Focal length = 4 mm ~ 130 mm or better,
vi)	Iris Control	Automatic with manual override
xiii)	Video Streams	Dual Stream: Primary stream: H.264 Secondary stream: H.264
b)	**Camera/Video:**	
i)	Available Resolution	Mainstream: 1920x1080/O.3-O.4MPx Sub Stream: 0.1-0.2MPx
ii)	Frame rate	Frames should be between 10-25 FPS,
iii)	Supported Protocols:	TCP, IPv4 / IPv6 compliant), NTP, UDP, Multicast(lGMP)
iv)	Security	Multiple user access with password protection
v)	Panning Range	Complete 360 degrees endless
vi)	Pan Speed	Variable 0.1 /sec 120 /sec
vii)	Tilting Range	Minimum 180 ^{0} Tilt Rotation (+/- 90 $^{0)}$
viii)	Preset Accuracy	+ 0.1 ^{0} or better
ix)	PTZ Tracking	The camera automatically pan, tilt & zoom to follow the moving object until the object stops or disappears from the monitored area.
c)	**Camera/Dome drive features:**	
i)	Video Motion Detection	To detect occurrence of motion in FOV of camera
d)	**Power Supply/Connector:** The camera should be supplied with suitable power supply cable as per Indian Standards.	
e)	**SDK/API kit for integration with Central VMS system:**	
	The Software Development Kit (SDK)/Application programming interface (API) for the Cameras shall be supplied by the vendor for integration with the central visual monitoring system and shall have the capabilities:	
	Network device discovery, live video streaming, Video capture configuration, video compression configuration, Event and metadata configuration, Rule management for alerts, Storage recording, PTZ camera control.	

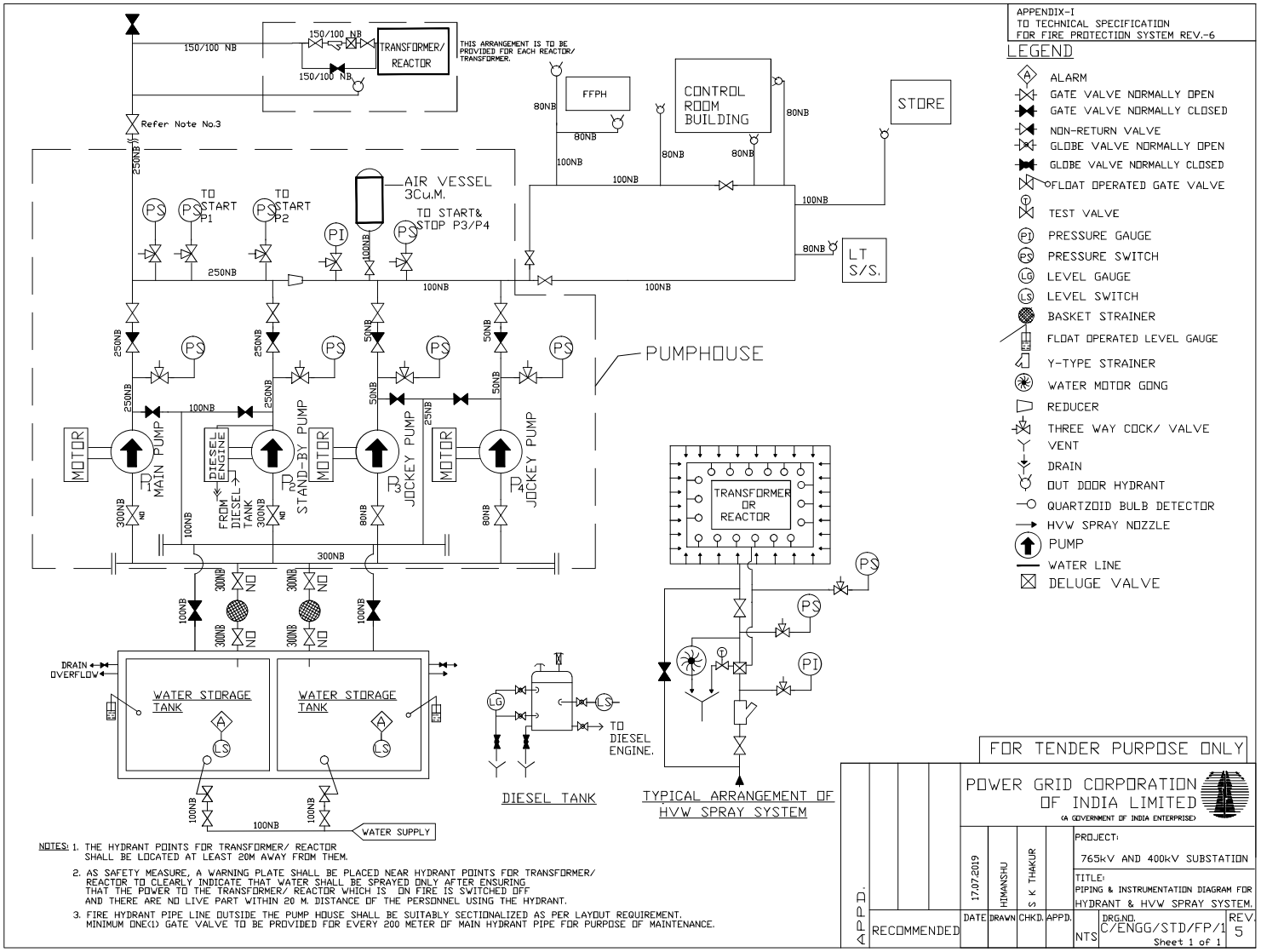
II. NVR (Network Video Recorder):

S No	Item	Characteristics
1	**Features**	
a	Processor	8 core or better
b	CPU/ Clock Speed	3.4GHz or better
c	RAM	DDR-3 or better, 8GB (2 x 4GB) or better
d	Hard Disk	The NVR should be supplied with at least 10 TB SAS based HDD from day-1.
e	Supports both IPv4 and IPv6	Yes
f	Supports SNMP v1, v2 and v3	Yes
2	**Interfaces:**	
a	I/O Ports	1 x Serial Port, 1 x Graphics, 1 x iLO Remote Manager shared with one Ethernet port
b	USB 3.0 Ports	02 nos.
c	Ethernet Port	01 no. (10/100/1000 Mbps)
d	Expansion Slots	PCIe Slots- 4nos
e	Operating System	Microsoft Windows latest version
f	Video Input	Minimum 10 channel
g	HDMI/VGA Output	HDMI – 01 no., VGA – 01 no.
h	Bandwidth Supported	Incoming minimum 50 Mbps; Outgoing minimum 40 Mbps
i	Recording Resolution	5MP or better 1080P or better
j	Protocols Supported	TCP/IP, ICMP, HTTP, DHCP, DNS, RTP, RTSP, RTCP, NTP, IGMP, QoS, IPV4, IPV6

III. POE Switch:

S No	Item	Characteristics
1	Interfaces:	• 16 nos. 10/100/1000 BASE-T based POE ports • 02 nos. SFP ports
2	Standards	IEEE 802.3u, 802.3af/at, 802.3ab, 802.3az, 802.3x
3	Power Requirements	150W (30 W max per PoE port)
4	Switching Capacity	01 Gbps

Note: The successful bidder shall supply camera along with a suitable Power Over Ethernet (PoE) Switch as per the above TS.



NOTES:
1. THE HYDRANT POINTS FOR TRANSFORMER/ REACTOR SHALL BE LOCATED AT LEAST 20M AWAY FROM THEM.
2. AS SAFETY MEASURE, A WARNING PLATE SHALL BE PLACED NEAR HYDRANT POINTS FOR TRANSFORMER/ REACTOR TO CLEARLY INDICATE THAT WATER SHALL BE SPRAYED ONLY AFTER ENSURING THAT THE POWER TO THE TRANSFORMER/ REACTOR WHICH IS ON FIRE IS SWITCHED OFF AND THERE ARE NO LIVE PART WITHIN 20 M. DISTANCE OF THE PERSONNEL USING THE HYDRANT.
3. FIRE HYDRANT PIPE LINE OUTSIDE THE PUMP HOUSE SHALL BE SUITABLY SECTIONALIZED AS PER LAYOUT REQUIREMENT. MINIMUM ONE(1) GATE VALVE TO BE PROVIDED FOR EVERY 200 METER OF MAIN HYDRANT PIPE FOR PURPOSE OF MAINTENANCE.

FOR TENDER PURPOSE ONLY

POWER GRID CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

	DATE	DRAWN	CHKD.	APPD.
RECOMMENDED	17.07.2019	HIMANSHU	S K THAKUR	
APPD.				

PROJECT: 765kV AND 400kV SUBSTATION

TITLE: PIPING & INSTRUMENTATION DIAGRAM FOR HYDRANT & HVW SPRAY SYSTEM.

NTS | DRG.NO. C/ENGG/STD/FP/1 | REV. 5

Sheet 1 of 1

TECHNICAL DATA SHEETS

DATA SHEET FOR DELUGE VALVE

1.0	Manufacturer	POWERGRID Approved make
2.0	Number & size	As per approved system drawings.
3.0	Type	Differential Diaphragm type
4.0	Rating	
4.1	Flow in M^3/hr. 1. 150 mm ø 2. 100 mm ø	170 to 650 50 to 225
4.2	Pressure	Working Pressure – 12.3 kg/cm^2 Test Pressure - 25 kg/cm^2
4.3	Pressure drop in equivalent length 1. 150 mm ø 2. 100 mm ø	 19M 11M
5.0	**Material of construction**	
5.1	Body	CI IS:210 Gr. FG 260
5.2	Valve internal	Cast Bronze – IS:318-LTB 2 / Ductile Iron ASTM A536 65-45-12
5.3	Seat Seal	EPDM/ Neoprene Rubber
5.4	Diaphragm	EPDM/ Neoprene Rubber
6.0	Differential pressure required for operation	Differential Ratio – 50%
7.0	Water Motor Gong provided	Yes
7.1	Type	Hydraulic type
7.2	**Material of Construction:**	
7.2.1	Housing	Al. Alloy-IS:617
7.2.2	Cover/Rotor./Gong	Aluminium to IS:737
7.2.3	Manual actuation lever provided?	Yes
8.0	Remote actuation with Solenoid Valve provided?	Yes
9.0	Resetting type	Manual resetting type
10.0	Deluge valve complete with test and drain valves, manual operation arrangement, supporting structures and all necessary accessories	Yes
11.0	Approval of Deluge Valve.	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

Annexure-S1

METHODOLOGY FOR SIZING OF CONTROL CABLES

S.No.	From	To	Cable size
1.	CB MB	CRP panels	i) 10CX2.5Sq mm ii) 19CX1.5 Sq mm iii) 27CX 1.5 Sq mm
2	CB MB	Earth switch MB	i) 3CX 2.5 Sqmm ii) 5C X2.5 Sq mm
3	Isolator MB	Earth switch MB	10CX1.5Sq mm
4	Isolator MB	CRP panels	19CX1.5 Sq mm
5	CT	CT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
6	CT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
7	CVT	CVT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
8	CVT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
9	LA	LA JB	3C X2.5 Sq mm
10	LA JB	CRP panels	5C X2.5 Sq mm
11	Reactor MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX1.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables
12	ICT MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX1.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables

METHODOLOGY FOR SIZING OF POWER CABLES

S.No.	From	To	Existing Cable size	Cable type
1.	Main Switch Board	LT Transformer	2-1C X 630 mm^2 :For each phase 1-1C X 630 mm^2 : for neutral	XLPE
2	Main Switch Board	AC Distribution Board	2-3½C X 300 mm^2	XLPE
3	Main Switch Board	Oil Filtration Unit	1-3½C X 300 mm^2	XLPE
4	Main Switch Board	Colony Lighting	1-3½C X 300 mm2	XLPE
5	Main Switch Board	HVW pump LCP	1-3½C X 300 mm2	XLPE
6	Main Switch Board	Main Lighting distribution board	2-3½C X 300 mm2	XLPE
7	AC Distribution Board	D.G. Set AMF Panel	For 500 kVA DG set: 2-3½C X 300 mm2 For 250 kVA DG set: 1-3½C X 300 mm2	XLPE
8	AC Distribution Board	Emergency Lighting distribution board	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	PVC
9	AC Distribution Board	ICT MB	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	PVC
10	AC Distribution Board	Bay MB	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 For 400/220kV S/s	PVC
11	Bay MB	AC Kiosk	1-4C X 16 mm2	PVC
12	AC Distribution Board	Battery Charger 220 V	1-3½C X 70 mm2	PVC
13	AC Distribution Board	Battery Charger 48 V	1-3½C X 35 mm	PVC
14	DCDB	Battery	2-1C X 150 mm2	PVC
15	DCDB	Battery Charger	2-1C X 150 mm2	PVC
16	DCDB	Protection/PLCC panel	1-4C X 16 mm2 : 765/400kV S/s 1-4C X 6 mm2: 400/220kV S/s	PVC
17	Main Lighting DB	Lighting panels(Indoor)	1-3½C X 35 mm2	PVC

18	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm2	PVC
19	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm2	PVC
20	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm2	PVC
21	Lighting Panel	Sub lighting panels	These Cables shall be included in Price of item for Lighting fixture	PVC
22	Lighting Panel	Street Lighting Poles	These Cables shall be included in Price of item for Lighting fixture	PVC
23	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	These Cables shall be included in Price of item for Lighting fixture	PVC
24	Bay MB	Equipment	1-4C X 16 mm^2 : For CB 1-4C X 6 mm^2: For Isolator/earths switch 1-2C X 6 : For CT/CVT	PVC
25	ELDB	Lighting panel	3½C X 70mm^2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	PVC

AIR CONDITIONING & VENTILATION SYSTEM FOR GIS BUILDING

AIR CONDITIONING SYSTEM FOR GIS

1. GENERAL

1.1. This specification covers supply, installation, testing and commissioning and handing over to POWERGRID of Air conditioning system for the Local Control rooms & Maintenance Room in the GIS halls.

1.2. Air conditioning system shall be designed to maintain the inside DBT below 24oC. Bidder shall submit necessary design calculations for employer's approval.

1.3. At least 50% spare Air-Conditioning capacity shall be provided for Local Control rooms in the GIS halls.

1.4. Controllers shall be provided in Local Control room inside GIS hall for controlling and monitoring the AC units in these rooms as detailed in clause no.2.6.

1.5. Each Local Control room inside GIS hall shall be provided with temperature transducer to monitor the temperature of the Local Control rooms in the GIS halls. The Temperature transducer shall have the following specification.

Sensor : Air temperature sensor (indoor use)
Output : 4 to 20mA
Temperature range : -5^{o}C to 60^{o}C
Resolution : 0.1^{o}C
Accuracy : 0.5^{o}C or better.

2. AIR CONDITIONING SYSTEM REQUIREMENTS.

2.1. Air conditioning requirement of the buildings shall be met using a combination of following types Air Conditioning units as required.

a) Cassette type split AC units of 3TR.
b) High wall type split AC units of 2TR

2.2. Type & Capacity of air conditioners shall be so chosen such that quantity of air conditioners in the room is optimized keeping the necessary air flow.

2.3. SCOPE

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

2.3.1. Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

2.3.2. Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

2.3.3. Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

2.3.4. First charge of refrigerant and oil shall be supplied with the unit.

2.3.5. GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

2.3.6. Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

2.3.7. All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.

2.3.8. PVC drain piping from the indoor units upto the nearest drain point.

2.3.9. Supply and erection of Power and control cable and earthing.

2.3.10. MS Brackets for outdoor condensing units, condensers as required.

2.4. Technical specifications

2.4.1. Cassette type split AC units

The Cassette type AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.4.1.1. Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.4.1.2. Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode etc.

2.4.1.3. Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have energy efficiency rating of 4 star as on the date of NOA.

2.4.2. **High wall type split AC units.**
The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.4.2.1. Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.4.2.2. The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

2.4.2.3. Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 4 star as on the date of NOA

2.5. Controllers shall be provided in Local Control room inside GIS hall, one controller for each room, to control and monitoring of AC units and shall have the following facilities.

- Standby units shall come in to operation automatically when the running main unit fails.
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:

a. Compressor On/OFF condition of each unit
b. Compressor failure of each unit
c. Power OFF to AC unit
d. High temperature in room

2.6. Warranty
All compressors shall have minimum 5 years Warranty from the date of commissioning.

Ventilation system for GIS Hall

Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

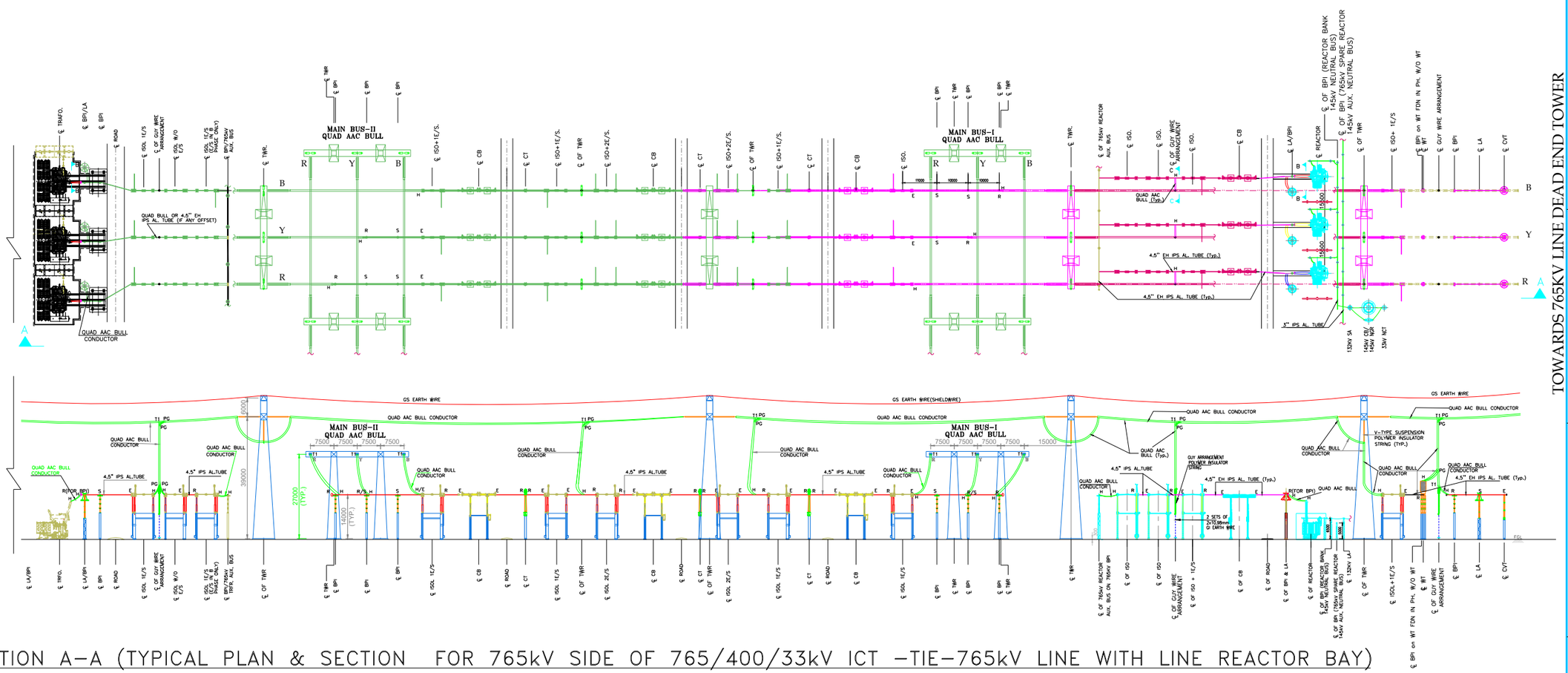
To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

1. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.

2. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

The ventilation of the GIS hall shall be of a positive pressure type with minimum 2 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.



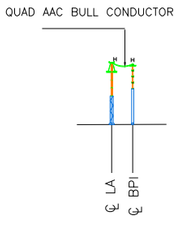
SECTION A–A (TYPICAL PLAN & SECTION FOR 765kV SIDE OF 765/400/33kV ICT –TIE–765kV LINE WITH LINE REACTOR BAY)

LEGENDS:

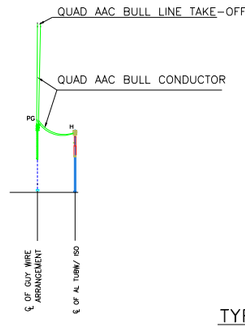
R– RIGID CONNECTION
E– EXPANSION TYPE CONNECTION
S– SLIDING TYPE CONNECTION
PG–PARALLEL GROOVE CONNECTION
T1– T1 TYPE CONNECTION (EACH T CONNECTOR SHALL BE OF TWIN TO TWIN CONDUCTOR TYPE FOR QUAD TO QUAD CONNECTION)
H– HORIZONTAL TYPE CONNECTION

NOTES:

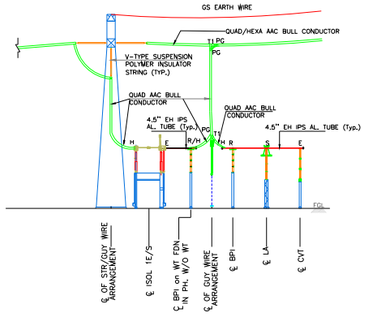
1) TWIN–TWIN CONNECTOR SHALL BE USED FOR QUAD–QUAD DROPPER CONNECTION.
2) AUXILIARY BUS ARRANGEMENT FOR 765kV TRANSFORMERS & REACTOR NEUTRALS, SPARE TRANSFORMER/REACTOR CONNECTION, TERTIARY ARRANGEMENT OF TRANSFORMERS ARE NOT SHOWN COMPLETELY.
3) CANTILEVER STRENGTH OF 765KV INSULATORS/BPI USED FOR 765KV ISOLATORS/WT SHALL BE OF 10KN AND FOR OTHER BPI IN SWITCHYARD SHALL BE OF 8KN MINIMUM.
4) HORIZONTAL TAKE–OFF OF JUMPERS AT EQUIPMENT LEVELS WITH ADEQUATE SAG SHALL BE PROVIDED



SECTION B–B



SECTION C–C



TYPICAL SECTION FOR 765KV LINE SIDE EUIPMENT CONNECTION ARRANGEMENT IN PHASE WITHOUT WT

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)	
TITLE: CONCEPTUAL CONNECTION ARRANMENT OF 765KV TRANSFORMER BAY–TIE BAY– LINE WITH LINE REACTOR BAYS	
DRAWING NO. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS	REV.2 SH.10F1

ANNEXURE- S4

SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE

For new 765kV and 400 kV AIS switchyard with one & a half breaker switching scheme, three gantry type arrangement (i.e. arrangement having single gantry in Tie bay) shall be considered. Further, Short-Circuit Forces (SCF) for the design of Gantry Structure and spacer spans shall be as mentioned below:

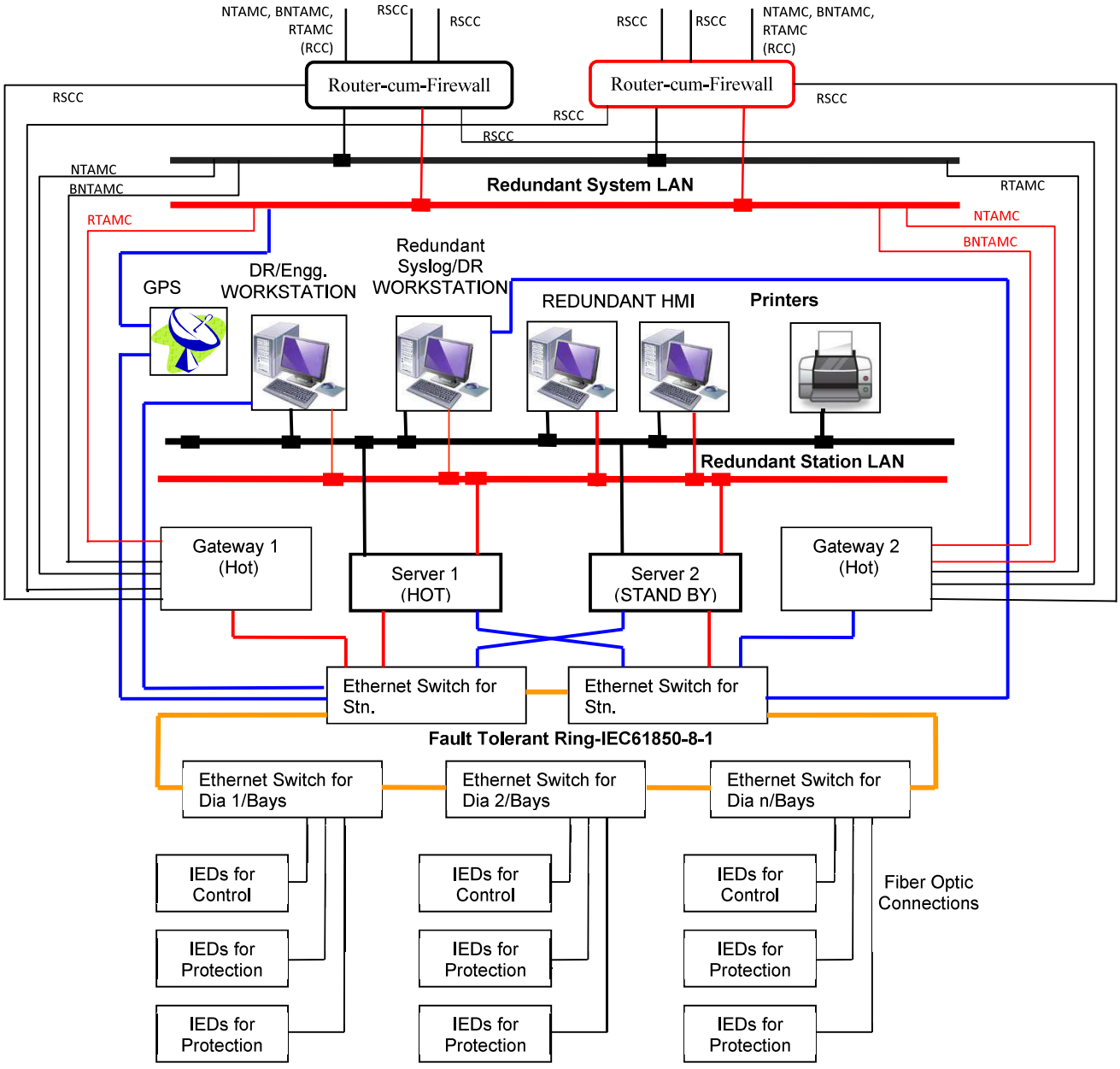
Voltage Level: 765kV, Fault Level: up to 50kA for 1 sec								
Bus Type	**Height of Bus (from FGL)**	**Max Span**	**Bus Conductor Configuration**	**Ph-Ph Spacing**	**Normal Tension per phase**	**SCF per phase**	**Spacer Span**	**Applicable Wind Speed**
Main Bus	27 Mtr	108 Mtr	Quad Bull	15Mtr	8T	9.75T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	140 Mtr		15Mtr	9.5T	11.26T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	114 Mtr		15Mtr	9.5T	11.10T	6Mtr	Upto 50m/s
Voltage Level: 400kV, Fault Level: up to 63kA for 1 sec, Bay Width : 24 Mtr								
Bus Type	**Height of Bus (from FGL)**	**Max Span**	**Bus Conductor Configuration**	**Ph-Ph Spacing**	**Normal Tension per phase**	**SCF per phase**	**Spacer Span**	**Applicable Wind Speed**
Main Bus	15mtr	72.0Mtr	Quad Bersimis	6.5mtr	5T	7.32T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	4Mtr	Upto 47m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	3.5Mtr	Upto 50m/s
Jack Bus	23Mtr	59.0Mtr		6.5mtr	5T	7.12T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	46.0Mtr		6.5mtr	4T	6.20T	4Mtr	Upto 50m/s

Above shall also be applicable for following cases unless otherwise specified elsewhere:

(i) Extension of 765kV switchyard with existing three gantry type arrangement
(ii) Extension of 400kV switchyard with existing three gantry type arrangement and having bus heights matching with above.

For design of gantry structures with spans, wind speed or conductor configurations other than that mentioned above, conductor tension shall be considered based on actual requirement of present & future scope of work. Relevant design calculations for such cases shall be submitted by the contractor for employer's approval.

TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) for New Substation



Note:

1. The redundant managed bus (station LAN) shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
2. Inside the sub-station, all connections shall be realized as per IEC 61850 protocol.
3. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-104 protocol. The number of ports required shall be as per clause no. 1.1 and 3.3 of this specification.
4. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder work stations.
5. The above layout is typical. However if any contractor offers slightly modified architecture based on their standard practice without compromising the working, the same shall be subject to approval during detailed engineering.
6. RCC means NTAMC/RTAMC. Similarly, RSCC could be SLDC for state owned substations/bays.
7. Syslog server to be Linux based. However DR/Engg. PC workstation can be other Operating System.

SPECIFICATION FOR SWITCHES

Substation System LAN:

2 (two) nos. managed Ethernet switches with 16 copper 10/100 Mbps RJ45 ports on each switch shall be supplied to form redundant system LAN as shown in typical architecture drawing. These switches shall be different from IEC 61850 LAN and specifically used for the purpose of connecting various devices of different sub-systems (SCADA, VMS, VOIP etc.) for integration with NTAMC/RTAMC. These switches shall be suitable for substation environment and shall comply with the requirements of IEC 61850-3 standard for EMI/EMC.

These LAN switches shall have the following compliance and functional features:

(a) Compliance as per NERC-CIP-3, NERC-CIP-5. NERC-CIP-7 standard for cyber security
(b) Support SNMPv3 (Full SNMP support including Traps)
(c) Web based GUI or CLI based with HTTPS/HTTP and SSH/ Telnet support
(d) Support for IPv4 and IPv6 switching simultaneously
(e) Layer 3 Static routing functionality
(f) Syslog facility for local as well as remote server
(g) Support for remote management
(h) LED indication for port status/supply etc.
(i) Shall support VLAN IEEE 802.1Q
(j) IGMP snooping
(k) Spanning tree protocol IEEE 802.1d or RSTP IEEE 802.1w
(l) Shall support SNTP
(m) Port based Network Access Control (IEEE 802.1x)
(n) Quality of Service (IEEE 802.1p)
(o) Shall support unicast as well as multicast IP traffic
(p) SNTP time synchronization
(q) Shall support Mac Binding
(r) Fanless design

Annexure-S7

Technical Specification for Next Generation Firewalls (NGFW)

1. NGFW shall have following features including but not limited to:
   Encryption through IPSec VPN (Virtual Private Network), Deep Packet Inspection (DPI), Denial of service (DoS) & Distributed Denial of Service (DDoS) prevention, Port Block/ Allow, rules/ policies for block/allow, IP (Internet Protocol) & Media Access Control (MAC) spoofing protection, threat detection, Intrusion Prevention System (IPS), Anti-Virus, Anti-Spyware, Man In The Middle (MITM) attack prevention.

2. The proposed firewall shall be able to handle (alert, block or allow) unknown /unidentified applications e.g. unknown TCP & UDP packets. It shall have the provision to define application control list based on application group and/or list.

3. Firewall shall have feature and also have capability to update the definition/ Signatures of Anti-Virus online as well as offline. Firewall shall also be compatible to update the definitions/signatures through CMC. There shall be a defined process for security patching and firmware up-gradation. There shall be a feature to field validate firmware checksum. The same shall also be validated before using the OEM provided file/binary in the process of firmware up-gradation and security patching

4. Firewall shall have Management Console port to configure remotely.

5. Firewall shall be EMI/EMC compliant in Substation environment as per IEC 61850-3.

6. Firewall shall be rack mounted in existing standard equipment cabinets.

7. Firewall shall have support of SCADA applications (IEC-60870-5-104), ICCP, PMU (IEEE C37.118), Sub-Station Automation System (IEC 61850), Ethernet and other substation environment protocols.

8. Client based Encryption/ VPN must support different Operating System platforms e.g. Windows, Linux & Mac.

9. The solution must have content and comprehensive file detection policies, blocking the files as function of their types, protocols and directions.

10. Firewall shall have logging facility as per standard logs/events format. Firewall shall have features to export the generated/stored logs/events in csv (Comma Separated Value) and also any other standard formats for offline usage, analysis and compliance. Firewall shall have suitable memory architecture and solution to store and be enable to export all logs/events for a period of last 90 days at any given time.

11. Firewall shall have features and be compatible with local as well as central authentication system (RADIUS, LDAP, or TACACS+) for user account and access right management. It shall also have Role Based User management feature.

12. Firewall shall have the capability to configure sufficient number of VLANs.

13. Firewall shall have the capability to support sufficient number of sessions.

14. Firewall shall have provision to configure multiple IP Sec VPNs, at least 100 nos., (one-to-many or many-to-one). Shall support redundant operation with a similar router after creation of all the IP Sec VPN. IPSec VPN shall be with encryption protocols as AES128, AES256 and hashing algorithms as MD5 and SHA1. IPSec VPN throughput shall be at least 300 Mbps.

15. Firewall shall be capable of SNMP v3 for monitoring from Network Management system. It shall also have SNMPv3 encrypted authentication and access security.

16. Firewall shall operate in Active/Passive or Active-Active mode with High Availability features like load balancing, failover for firewall and IPsec VPN without losing the session connectivity.

17. Firewall should have integrated traffic shaping (bandwidth, allocation, prioritisation, etc.) functionality.

18. Shall support simultaneous operation with both IPv4 and IPv6 traffic.

19. Firewall shall be compatible with SNTP/NTP or any other standards for clock synchronization.

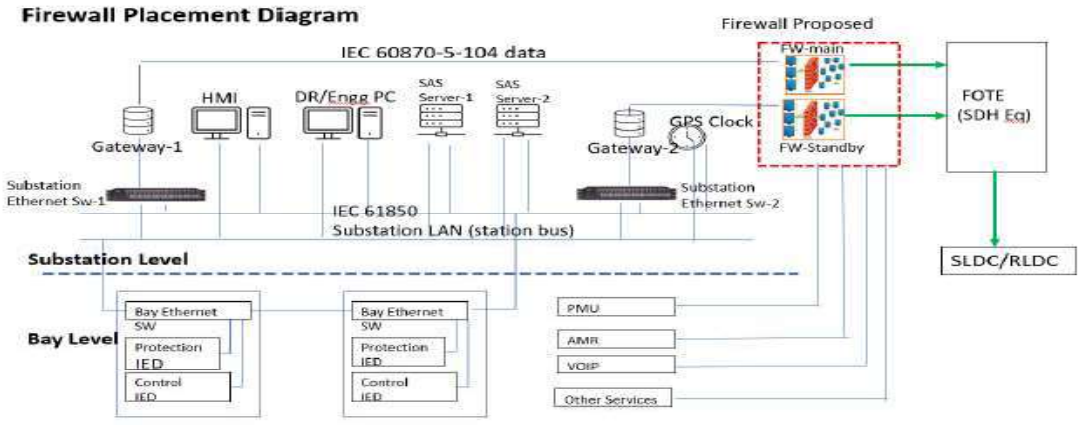
20. Firewall shall have the features of port as well as MAC based security.

21. Firewall shall support exporting of logs to a centralized log management system (e.g. syslog) for security event and information management.

22. Firewall time shall be kept synchronised to official Indian Timekeeping agency, time.nplindia.org.

23. Firewall product shall be provided with all applicable updates at least until 36 months since the applicable date of product shipping to the concerned utility.

Figure-I



SPECIFICATION FOR DIGITIAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cablesystem

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+15%/-20%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port. It shall provide suitable interfaces for protective relays, which operate at 220V DC. Power supply points shall be immune to electromagnetic interface

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a buttonon the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signalling equipment shall be designed and provided with following feature.

- Shall work in conjunction with SDH terminal equipment.
- It shall communicate on G 703 (E1,2 Mbps)
- Full Duplex operation
- Auto loop facility shall be provided
- Shall meet IEC 60834-1 standard
- Shall be able to transmit upto 4 commands with trip counter simultaneouslyor sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. With regard to trip counters alternate arrangement .i.e. Laptop along with software & all accessories to download eventsincluding carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel.

Reports of the following tests as per clause 9.2 of Section-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) **General equipment interface tests:-**

a) Insulated voltage withstand tests
b) Damped oscillatory waves disturbance test
c) Fast transient bursts disturbance test
d) Electrostatic discharge disturbance test
e) Radiated electromagnetic field test
f) RF Disturbance emission test

ii) **Specific power supply test**

a) Specific power supply test
b) Power supply variations
c) Interruptions
d) LF disturbance emission
e) Reverse polarity

iii) **Tele-protection system performance test:-**

a) Security
b) Dependability
c) Jitter
d) Recovery time
e) Transmission time
f) Alarm functions
g) Temperature and Humidity tests (As per IEC 68-2)

- Dry heat test (50°C for 8 hours
- Low temperature test (-5°C for 8 hours)
- Damp heat test (40°C/95%RH for 8 hours

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC

60834-1 and the standards mentioned therein.

iv) **Relays**

a) Impulse voltage withstand test as per clause 6.1 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686

b) High frequency disturbance test as per clause 5.2 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686).

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follow.

i) Power supply 48V DC +15% /-20%

ii) Number of commands 4 (four)

iii) Operating time <7 ms

iv) Back to back operate time without propagation delay ≤ 8 ms

v) Interface to Protection relays

Input: Contact Rating:

Rated voltage : 250 volts DC

Maximum current rating: 5 amps

Output: Contact Rating:

Rated voltage : 250 volts DC

Rated current : 0.1 A DC

Other parameters : As per IEC-255-0-20

vi) Alarm contact

Rated voltage : 250 volts DC

Rated current : 0.1 A DC

Other parameters : As per IEC-255- 0-20

vii) Digital communication interface: G 703(E1

Technical Specification for Visual monitoring system for watch and ward of Substation premises:

Visual monitoring system (VMS) for effective watch and ward of sub station premises covering the areas of entire switchyard, Control Room cum Administrative building, Fire fighting pump house, stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor.

System with Color IP Cameras for VMS surveillance would be located at various locations including indoor areas and outdoor switchyard and as per the direction of Engineer-In-Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

1. The operation of each and every isolator pole of the complete yard in case of AIS Sub-station.
2. The Operation of each bay(s) of GIS Hall as Applicable.
3. All the Transformer and Reactors All the Entrance doors of Control Room Building and Fire-fighting Pump House, GIS Hall and Switchyard Panel room as applicable.
4. All the gates of switchyard.
5. Main entrance Gate
6. All other Major AIS Equipment (such as CB, CT, CVT, SA etc. as applicable)

   The cameras can be mounted on structures, buildings or any other suitable mounting arrangement to be provided by the contractor.

1.1 Technical requirements of major equipment of Visual Monitoring System.

1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.

1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

1.1.3 The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using **H 264**/MPEG 4 or better standard. Mouse/Joystick-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.

1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more

@ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.

1.1.5 The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System.

1.2 System requirements:

a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.

b) All cameras may be connected through a suitable LAN which shall be able to perform in 765kV class sub-station environment without fail.

c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.

f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.

g) In order to optimize the memory, while recording, video shall be compressed using H **264**/MPEG-4 or better standard and streamed over the IP network.

h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

i) The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

j) System shall have provision of WAN connectivity for remote monitoring.

k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-18
3. AC Voltage Dips & Interruption/Variation (class 3) – As per IEC 61000-4-11
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC input Power Supply Port immunity test(level 4) - As per IEC 61000-4-17

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.

b) The software should have inbuilt facility to store configuration of encoders and cameras.

c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.

d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.

f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.

g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 22" High resolution monitor, and Internal DVD writer. Windows XP/Vista/7 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1.	Server Spec	Intel Quad Core (or better) 3.0 Ghz (min.) , 8 MB Cache , 4 GB memory , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2.	Recording and Display Frame Rate	Real-time 25 frames per second per channel , manual select

3.	Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
4.	Compression Method	H.264/MPEG-4 or better and latest
5.	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6.	Monitoring Options	Split screen 1, 2, 4 , 8, 16, 32 or more cameras
7.	Playback Options	Search, still image capture
8.	Alarm/Event Recording Capable	To be provided with built-in external alarm input/ output ports minimum(8 in, 2 out)
9.	Network Operation Capable	To be provided by using WAN or LAN router
10.	Remote Internet Viewing Capable	Using WAN or LAN router
11.	HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
12.	Operation	Triplex operation (simultaneous recording, playback, network operation)
13.	Number of Video Channel	32
14.	Audio Recording Capable	32
15.	Input Voltage	230V AC or equivalent with UPS as a back up for 30 minutes.

1.2.3 VMS Camera

a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the POWERGRID premises as per the direction of Engineer-In-Charge

b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit

c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.

d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.

e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.

f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux

g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 765/400KV switchyard.

h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password

i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1.	Image Sensor	2-megapixel Progressive ,1 / 3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5LUX(Color) 0.05Lux(Black)
3.	Camera Enclosure Type	IP66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG 4 user selectable
6.	Support Dual-stream	primary/secondary stream, H.264/MPEG 4 optional
7.	Video Definition	Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25frames/second NTSC:1-30frames/second
10.	Video Compression BR	32Kbit/S - 6Mbit/S
11.	Video Output	One channel composite Streaming
12.	Supported Protocols	TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13.	Operating Temperature	-5 ~ +50°C
14.	Operating Humidity	10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1.	Image sensor	1/3 type Solid State Progressive Scan CCD,WDR(High Definition)
2.	Security	Multiple user access with password protection
3.	Effective Pixels	**(PAL): Main Stream：1280x720** Sub Stream：640x360、320x280 selectable
4.	Compression	Dual Stream H.264 and MPEG 4 user selectable
5.	Signal System	50 Hz
6.	S/N (signal to noise) Ratio	Better than 50 dB
7.	Electronic Shutter	1/60 ~ 1/10,000 sec. automatic or better
8.	Scanning System	Progressive/interlace
9.	Low Light Sensitivity (lux)	Color: 0.5 Lux; B&W:0.02 Lux
10.	Lens	Minimum 10x (minimum) optical in High Definition **(The system shall be able to zoom the images on the monitor without any distortion to the maximum level of optical zoom)**
11.	Lens Size	Minimum 4.1~73.8 mm
12.	Lens Aperture	F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13.	PTZ Data Transfer Baud/Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps

14.	Panning Range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degrees / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degrees / second ~ 150 degrees / second
18.	In Built Storage	Camera should have inbuilt storage TF or SD format for recording and storing Pictures
19.	IP Class	IP66 Standard
20.	Working temperature	-0℃ ~ +50℃
21.	Working Humidity	10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include:

- Fully functional dynamic keyboard/joystick controllers
- Controls all pan, tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

1.	Key Application	wired keyboard control operation of PTZ functions for weatherproof dome cameras
2.	Pan / Tilt / Zoom Protocol Languages Supported	Selectable
3.	PTZ Data Transfer Baud Rates Supported	selectable 1200 bps / 2400 bps / 4800 bps / 9600 bps
4.	Additional Features	dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

Annexure- S10

ANNEXURE-12

Of Section-GIS Rev 5A

Reference Guidelines for GIS Grounding

1. GIS Grounding

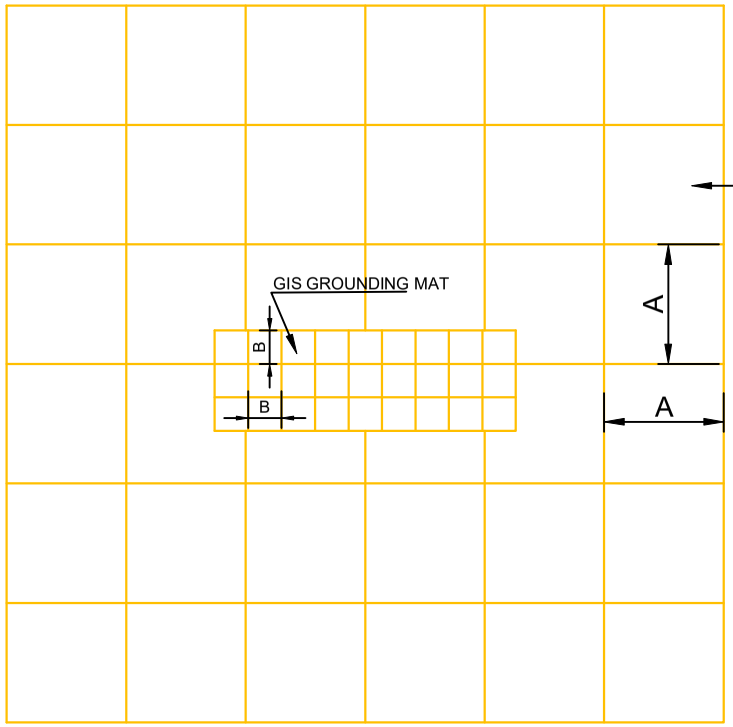
These reference guidelines are minimum requirement and do not override manufacturer's recommendations or design criteria. These Reference Guidelines shall be read and implemented in conjunction with manufacturer recommendation/Criteria for GIS grounding design.

GIS Grounding system shall be designed to provide low-impedance grounding path for ground fault currents. Very Fast Transient generated due to electrical breakdown in the insulating gas, either across the contacts of a switching device during operation or under fault conditions shall also need to be considered in the overall grounding design for GIS. Grounding conductors or system of conductors shall be provided for connecting all designated metallic components of gas-insulated substation (GIS) to a substation grounding system.

1.1. **Power Frequency Grounding**: Manufacturer recommended designated grounding points of GIS equipment shall be connected with the risers directly coming from buried main GIS grounding mat. The Size of the conductor (copper) for making this connection shall be submitted by GIS manufacturer based on the specified fault current and its duration. The location and numbers of above said risers shall be as per the manufacturer recommended designated grounding points for GIS equipment. Main GIS grounding mat shall be buried at the level of station grounding mat. It shall be made up of same conductor as that of station grounding mat. The spacing of main GIS grounding mat for different voltage levels of GIS shall be as per attached Typical Drawing.

1.2. **High Frequency Grounding of GIS equipment**: Dedicated copper grounding mesh with specified spacing and cross-section shall be provided at the top of GIS building finished floor level. This dedicated copper grounding mesh shall be spread-over, beneath complete GIS switchgears installation and extended up to 500 mm away in all direction from GIS switchgears installation. This dedicated copper grounding mesh shall be directly connected to the GIS enclosures (min. at two distant points in each phase/bay) and to the risers directly coming from GIS grounding mat (min. at two distant locations per phase/bay) with the shortest path to the connection point. All Crossing of copper grounding mesh shall be suitably clamped/welded together. Bolted joint at crossings is not allowed, further this copper grounding mesh shall be clamped adequately to the floor at suitable locations. At the jointing of two different metals the joint shall be made using requisite bi-metallic jointer. This dedicated copper grounding mesh is laid at the top of GIS floor and shall also be connected with dedicated grounding rod electrodes provided at a regular interval of not more than 12 meters around periphery of GIS building. This copper grounding mesh shall be laid after the GIS bays are place on the floor and shall be suitably covered with Non-Electrostatic rubber mats to avoid damage to mesh and to avoid hinderance in regular operation of equipment. The Spacing, conductor detail and cross-section of copper grounding mesh shall be as per attached Typical Drawing.

Typical Drawing No, Standard/GIS/GROUNDING/01 for above said grounding recommendation is part of this document.



A - TYPICAL SPACING FOR STATION GROUNDING MAT

B - TYPICAL SPACING FOR MAIN GIS GROUNDING MAT

C - COPPER GROUNDING MESH

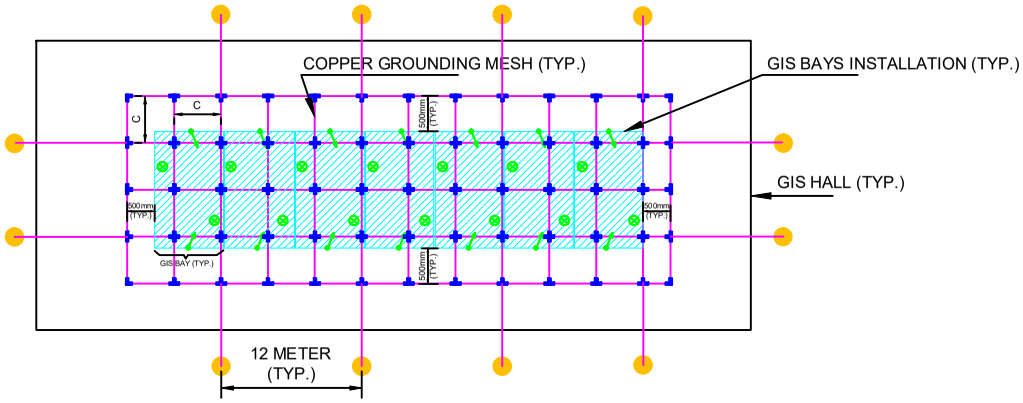
CONNECTION POINT OF COPPER GROUNDING MESH WITH GIS ENCLOSURE (TYP.)

CONNECTION POINT OF COPPER GROUNDING MESH WITH MAIN GIS GROUNDING MAT RISERS(75X12 MM GI FLAT) (TYP.)

COPPER CLAMP/ WELDED JOINT (TYP.)

3000mm LONG, 40mm DIA ROD ELECTRODE

	STATION GROUNDING MAT			MAIN GIS GROUNDING MAT			COPPER GROUNDING MESH			
VOLTAGE LEVEL	TYPICAL SPACING (MTRxMTR)	PLACEMENT AT (TYP.)	CONDUCTOR (TYP.)	TYPICAL SPACING (MTRxMTR)	PLACEMENT AT (TYP.)	CONDUCTOR (TYP.)	TYPICAL SPACING (MTRxMTR)	PLACEMENT AT (TYP.)	CONDUCTOR	CONDUCTOR CROSS SECTION
765kV	AS PER STATION GROUNDING DESIGN	600MM BELOW FGL	40MM DIA. MS ROD	5x5	600MM BELOW FGL	40MM DIA. MS ROD	5x5	GIS BUILDING FLOOR FFL	COPPER STRIP	50x6mm
400kV				3x3			3X3			50x6mm
220kV & 132kV				3x3			---			---



NOTES:-

1. THIS DRAWING SHALL BE REFEREED AS COLORED PRINT ONLY.
2. THESE REFERENCE GUIDELINES DO NOT OVERRIDE MANUFACTURER'S RECOMMENDATIONS OR DESIGN CRITERIA. THESE REFERENCE GUIDELINES SHALL BE READ AND IMPLEMENTED IN CONJUNCTION WITH MANUFACTURER RECOMMENDATION/CRITERIA FOR GIS GROUNDING DESIGN.
3. THE MAIN GIS GROUNDING MAT SHALL BE LAID BENEATH GIS BUILDING COVERING LENGTH AND WIDTH OF GIS BUILDING.
4. ANNEXURE FOR "REFERENCE GUIDELINES FOR GIS GROUNDING" ENCLOSED.

POWER GRID CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

TITLE: TYPICAL GIS GROUNDING REFERENCE GUIDELINES

DATE	DRAWN	SCALE	DRG.NO. STD/GIS/GROUNDING/01	REV
JAN 2023		NTS		0

Annexure-S11

ANNEXURE- 13
Of GIS Rev5A

DESCRIPTION OF GIS BAY MODULE & EQUIPMENTS

765kV Gas Insulated Switchgear (One & half breaker Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type & configuration of different GIS modules shall be as specified below:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.

ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 1-phase Potential Transformers.

v. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

vi. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece (interface) module for both the buses shall be in one alignment.

> Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vii. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

viii. Local Control Cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

iii. Extension piece (Interface) module, as required to extend existing bus so as to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended .

iv. End Piece (Interface) modules with isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece (interface) module for both the buses shall be in one alignment.

v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker (**#)** with/without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers, 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. One (1) number 3-phase, single pole, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers single phase, SF6 ducts inside GIS hall (up to the outer edge of the wall of GIS Hall).

viii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc., as required.

ix. Local Control Cubicle.

'#' As per BPS

iv) GIS Tie Bay module:

SF6 gas-insulated metal enclosed Tie bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

'#' As per BPS

v) GIS ICT Bay module:

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers 1-phase, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

xi. Local Control cubicle.

vi) GIS Bus Reactor Bay module:

SF6 gas insulated metal enclosed Bus Reactor Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Bus reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

xi. Local Control cubicle.

vii) GIS Switchable Line Reactor Bay module:

SF6 gas insulated metal enclosed Switchable Line reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. One (1) number 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.

iii. One (1) number 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Line reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

vii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

viii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

ix. Local Control cubicle.

viii) GIS Line Reactor Bay module:

SF6 gas insulated metal enclosed Non-Switchable Line reactor bay module, each set comprising of the following:

i. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

ii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Line reactor through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

vi. Local Control cubicle (if required separately).

ix) GIS Auxiliary Bus module for Spare ICT Connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) number single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

x) GIS Auxiliary Bus module Extension for Spare ICT connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

xi) GIS Auxiliary Bus module for Spare Reactor Connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for Reactor bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of Reactor with all Reactor Bay Modules through GIS Duct and provision of extension for future Reactors.

ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) number single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

vi. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

xii) GIS Auxiliary Bus module Extension for Spare Reactor connection:

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for Reactor bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of Reactor with all Reactor Bay Modules through GIS Duct and provision of extension for future Reactors.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

xiii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionaliser Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) Numbers single phase, SF6 ducts for interconnection of above mentioned elements.

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

viii. Local Control Cubicle

420kV Gas Insulated Switchgear (One & half breaker Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.

ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers 1-phase Potential Transformers complete with manual operated isolating Switch/device.

iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

> Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

vii. Local Control Cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in one and a half breaker bus system.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) modules with the isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker (**#)** with/without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers, 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. One (1) number 3-phase, single pole, high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers single phase, SF6 ducts inside GIS hall (up to the outer edge of the wall of GIS Hall).

viii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc., as required.

ix. Local Control Cubicle.

'#' As per BPS

iv) GIS Tie Bay module:

SF6 gas-insulated metal enclosed Tie Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker (#) with/without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on other side of circuit breaker

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

'#' As per BPS

v) GIS ICT bay module (For 400kV side of 765/400kV ICT):

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers 1-phase, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

ix. Three (3) numbers single phase SF6, ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

xi. Local Control cubicle.

vi) GIS Auxiliary Bus module for Spare ICT Connection (For 400kV side of 765/400kV ICT):

Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) number, single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Auxiliary Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vii) GIS Auxiliary Bus module Extension for Spare ICT connection (For 400kV side of 765/400kV ICT):

Set of isolated phase, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

viii) GIS ICT bay module (For 400kV HV side of 400/220kV ICT):

SF6 gas-insulated metal enclosed ICT bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

viii. Local Control Cubicle.

ix) GIS Bus reactor bay module:

SF6 gas insulated metal enclosed Bus reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

vii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

viii. Local Control cubicle.

x) GIS Line Reactor Bay module:

SF6 gas insulated metal enclosed Line reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

ii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

v. Local Control cubicle (if required separately).

xi) GIS Switchable Line reactor bay module:

SF6 gas insulated metal enclosed switchable Line reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

vi. Local Control cubicle.

Note: Quantity of "3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms" and "3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms" shall be Two (2) nos. in case of direct connection of Line Reactor with GIS.

xii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionaliser Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts for interconnection of above mentioned elements.

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

viii. Local Control Cubicle

420 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.

ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers 1-phase Potential Transformers complete with manual operated isolating Switch/device.

iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.

v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

> Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three isolated phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) no's individual bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.

iii. Extension piece (Interface) module, as required to extend existing bus so as to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) modules with the isolating test link for Future extension of Bus bar module on one side. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

v. Three (3) numbers single phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

i One (1) number 3-phase, SF6 insulated circuit breaker (**#)** with/without PIR complete with operating mechanism.

ii Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi One (1) number 3-phase, single pole, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.

vii Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall)

viii Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

ix Local Control Cubicle.

'#' As per BPS

iv) GIS ICT bay module (For 400kV side of 765/400kV ICT):

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms.

vii. Three (3) numbers 1-phases, individual pole operated safety grounding switches, complete with manual and motor driven operating mechanisms.

viii. Three (3) numbers 1-phase, individual pole operated isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through Auxiliary bus. The isolator must meet the operational requirement in terms of Phase-phase insulation withstand capability.

ix. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

x. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

xi. Local Control cubicle.

v) GIS Auxiliary Bus module for Spare ICT Connection (For 400kV side of 765/400kV ICT):

Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. One (1) number 1-Phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) number, single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

v. End Piece (Interface) module with Isolating test link for Future extension **on one side** of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi) GIS Auxiliary Bus module Extension for Spare ICT connection (For 400kV side of 765/400kV ICT):

Set of isolated phases, SF6 gas-insulated metal enclosed Auxiliary bus bars module for ICT bays, each set comprising of the following:

i. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of ICT with all ICT bay Modules through GIS Duct and provision of extension for future ICT.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc. as required.

iii. Extension piece (Interface) module, as required to extend existing Auxiliary bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) module with the Isolating test link for Future extension (on one side) of Auxiliary Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

vii) GIS ICT bay module (For 400kV HV side of 400/220kV ICT):

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

viii. Local Control Cubicle.

viii) GIS Bus Coupler Bay module:

SF6 gas-insulated metal enclosed Bus Coupler Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

ix) GIS Bus Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Three (3) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

viii. Local Control Cubicle.

x) GIS Line reactor bay module:

SF6 gas insulated metal enclosed Line reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

ii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

iv. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

v. Local Control cubicle (if required separately).

xi) GIS Switchable Line reactor bay module:

SF6 gas insulated metal enclosed switchable Line reactor bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker without PIR, complete with operating mechanism.

ii. One (1) number 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iii. One (1) number 3-phases, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers single phase, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

v. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structures etc., as required.

vi. Local Control cubicle.

xii) GIS Bus Section Module:

SF6 gas-insulated metal enclosed Bus Sectionaliser Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker without PIR, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 3-core, multi ratio, current transformers (CTA) on one side of circuit breaker.

iii. Three (3) numbers 1-phase, 2-core, multi ratio, current transformers (CTB) on other side of circuit breaker.

iv. Two (2) numbers 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.

v. Two (2) numbers 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi. Three (3) numbers single phase, SF6 ducts for interconnection of above mentioned elements.

vii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, Support structures etc., as required.

viii. Local Control Cubicle

245 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

3-single (isolated) phase/Three phase enclosed, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Three (3) numbers single(isolated) phase / One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.

ii. One (1) number 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

iii. Three (3) numbers 1-phase Potential Transformers, complete with manual operated isolating Switch/device.

iv. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.

v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.End piece interface module for both the buses shall be in one alignment.

> Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi. Three (3) numbers single(isolated) phase / One (1) number three phase, SF6 ducts (as required) inside GIS hall

vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of 3-single (isolated) phase/Three phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. Bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.

ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.

iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) modules with the isolating test link for Future extension (on one side) of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

v. Three (3) numbers single(isolated) phase / One (1) number three phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

i One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.

ii Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v One (1) number 3-phase, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.

vi Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall)

vii Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

viii Local Control Cubicle.

iv) GIS ICT bay module:

SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

v) GIS Bus Coupler Bay module:

SF6 gas-insulated metal enclosed Bus Coupler Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vi. Local Control Cubicle.

vi) GIS Bus Section Bay module:

SF6 gas-insulated metal enclosed Bus Section Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Three (3) numbers single phase(isolated) / One (1) number three phase , SF6 ducts for interconnection of above mentioned elements.

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

vii) GIS Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vi. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.

vii. Local Control Cubicle.

145 kV Gas Insulated Switchgear (Double Main Busbar Scheme)

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module:

Sets of three phase enclosed, SF6 gas-insulated metal enclosed Bus Bar modules, each set comprising of the following:

i. One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double main bus bar system.

ii. One (1) number 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) number 3-phase inductive potential transformers, complete with manual operated isolating Switch/device.

iv. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

v. End Piece (Interface) modules with isolating test link for Future extension **on one side** of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

> Project Specific Requirement: Requirement of End Piece (Interface) module with isolating test link **on both side** of Bus bar module shall be considered based upon GIS Layout as and when specified under Section-Project.

vi. One (1) number three phase, SF6 ducts (as required) inside GIS hall.

vii. Local control cubicle (if required separately).

ii) GIS Bus bar Module Extension (Make of Existing GIS: As per Section-Project):

Extension of Three phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

i. One (1) number three phase Bus bar enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system.

ii. Gas monitoring devices, barriers, pressure switches, support structure etc. as required.

iii. Extension piece (Interface) module, as required to extend existing bus to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.

iv. End Piece (Interface) modules with the isolating test link for Future extension (on one side) of Bus bar module. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. End piece interface module for both the buses shall be in one alignment.

v. One (1) number three phase, SF6 ducts (as required) inside GIS hall.

iii) GIS Line bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. One (1) number 3-phase, high speed fault making grounding switch, complete with group operated manual and motor driven operating mechanisms.

vi. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vii. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

viii. Local Bay control cubicle.

iv) GIS ICT bay module:

SF6 gas-insulated metal enclosed ICT feeder bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

v. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

vii. Local Bay control cubicle.

v) GIS Bus Coupler Bay Module:

SF6 gas-insulated metal enclosed Bus-Coupler Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

vi. Local Bay Control Cubicle.

vi) GIS Bus Section Bay Module:

SF6 gas-insulated metal enclosed Bus Section Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Two (2) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. One (1) number 3-phase, SF6 ducts for interconnection of above mentioned elements.

vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

vii. Local Bay Control Cubicle.

vii) GIS Reactor Bay module:

SF6 gas-insulated metal enclosed Reactor Bay module, each set comprising of the following:

i. One (1) number 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.

iii. Three (3) numbers 3-phase, group operated isolator switches complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

v. One (1) number 3-phase SF6 ducts inside GIS hall (upto the outer edge of the wall of GIS Hall).

vi. Gas monitoring devices, barriers, pressure switches, support structures etc. as required.

vii. Local Bay control cubicle.

Gas Insulated Outdoor Bus Duct (GIB):

(i) **765kV & 420kV GIB:**

For making connections with outdoor overhead lines/Transformer/Reactor, Single Phase enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch, UHF PD Sensor etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

(ii) **245kV GIB:**

For making connections with outdoor overhead lines/Transformer/Reactor, **Single/Three Phase** enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch, UHF PD Sensor etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

(iii) 145kV GIB:

For making connections with overhead lines/Transformer/Reactor, Three Phase enclosed SF6 Gas Insulated Bus Duct (including support structure, gas monitoring device, gas barrier, pressure switch etc.) shall be provided. The GIB shall be measured in running meter as per actual at site and the same shall be paid as per unit rate quoted in Bid Price Schedule. This outdoor bus duct shall be measured from outer wall edge of GIS Building to centerline of SF6 to Air Bushing/ SF6 to Oil Bushing (as applicable). SF6 gas duct inside GIS building are part of respective GIS Bay Module.

The GIB duct length shall be optimized further meeting present & future bay requirements without affecting the switchyard arrangement, bay orientation and any of the specified functional requirements.

Gas Insulated SF6 to Air Termination:

For making connections with overhead lines/Transformer/Reactor, SF6 to Air bushing including accessories shall be as specified below:

(i) **For 765kV/420/245/145kV:** SF6 to air bushings along with terminal connectors & support structure etc. as required for outdoor connections to connect GIS with overhead line/Transformer/Reactor.

Gas Insulated SF6 to Oil Termination:

For making direct connections with Transformer/Reactor, GIS Interface module along with associated active parts to facilitate the direct connection of GIS duct with Transformer/Reactor is under the present scope of subject package which is as specified below:

(i) **For 765kV/420/245/145kV:** 1-phase Gas insulated interface module along with associated active parts to facilitate the direct inter-connection of GIS duct with the Transformer/Reactor.

Supply of SF6 to Oil bushing is in the scope of Transformer/Reactor Manufacturer. The limits of supply of the GIS switchgear manufacturer and transformer manufacturer shall be as per IEC 62271-211. The drawings/details of SF6 to Oil bushing along with other required data of Transformer/Reactor shall be provided during detailed engineering.

Gas Insulated SF6 to Cable Termination:

For making connections of GIS switchgear/duct with XLPE Cable, GIS Interface module along with associated active parts to facilitate the connection of GIS switchgear/duct with XLPE Cable as per IEC-62271-209 is under the present scope of subject package which is as specified below:

(i) **For 245kV:** 1-phase / 3-Phase Gas Insulated SF6 to cable connection module along with associated active parts to interconnect GIS with XLPE Cable. The Support Structure required to support the XLPE cable upto the GIS termination point is also in the present scope of subject package.

(ii) **For 145kV:** 3-Phase Gas Insulated SF6 to cable connection module along with associated active parts to interconnect GIS with XLPE Cable. The Support Structure required to support the XLPE cable upto the GIS termination point is also in the present scope of subject package.

Supply of XLPE Cable along with termination kit is in the scope of Cable Manufacturer. The limits of supply of the GIS switchgear manufacturer and Cable termination shall be as per IEC 62271-209.The drawings/details of XLPE cable along with termination kit shall be provided during detailed engineering.

Gas Insulated Surge Arrester:

(i) **For 765kV/420kV :** 1-phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)

(ii) **For 245kV:** 1-phase/3-Phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)

(iii) **For 145kV:** 3-phase Gas insulated Surge Arrester along with required accessories (i.e. surge monitor etc.)

Factory Acceptance Test (FAT) Procedures & Formats

- Substation Automation System

Power Grid Corporation of India Ltd.
Saudamini, Plot no.2, Sector-29, Gurgaon, Haryana 122 001

DOC: PG/CC/SAS/FAT, Rev04				
Revision	**Department**	**Date**	**Signature**	**Signature**
01	Engg	-	-	-
02	CC/Engg CC/QAI CC/AM	09.11.2023	Sd/	Sd/
03	CC/NTAMC CC/AM	19.01.2024	Sd/	Sd/

REVISION HISTORY

Sl.No.	Pages	Revision	Remarks
01	All Pages	01	Initial Release
02	All Pages	02	Major revision
03	All Pages	03	Minor revision
04	All Pages	04	Minor revision

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

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POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

ABOUT THIS DOCUMENT

PURPOSE OF THIS DOCUMENT

This document shall be used as a standard for conducting all tests during the Factory Acceptance Test (FAT) for the typical Substation Automation System (SAS) of every substation as per POWERGRID requirements and specifications.

The aim of the Factory Acceptance Test (FAT) is to demonstrate equipment and functionality as well as the approval of the system-parameterization by POWERGRID to reduce the change requests during commissioning at site. 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.

During FAT the entire Sub-station Automation System including the complete control and protection system to be supplied shall be tested for complete functionality and configuration in the factory itself for both green field and brown field projects. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure defect free installation at site. No major change in configuration/setting of system is envisaged at site.

In case of extension/Augmentation packages, the existing make SCADA system of the substation where extension is proposed shall be used to carry out the validation of extension bays signals, control commands, etc.

This document details the equipment and functions under test and the corresponding test methods as well as the test documentation.

WHO SHOULD USE THIS DOCUMENT

This document needs to be used by the Vendor representatives (Q&I, Engg, Factory) for Factory acceptance test as per the project requirement. This approved document will be followed by the Vendor Representatives (Q&I, Engg, Testing) and POWERGRID representatives to test and evaluate the complete system.

1. GENERAL

INTRODUCTION

The purpose of this document is to define the Factory Acceptance Test procedures of Substation Automation System (SAS) for supplied by the Vendor to POWERGRID.

The tests are performed by Vendor and each test, or set of tests as appropriate, is covered by an approval stage, which will be signed off upon completion by Vendor and POWERGRID representatives.

Comments are noted in separate Observation and correction reports (snag list) attached as annexure.

2. PRE-FAT – PREREQUISITES

2.1. ENGINEERING DOCUMENTS

Purpose:

This test verifies that the correct manufacturing drawings and documentation for the equipment/system under the test will be used during the Factory Acceptance Test.

Procedure

1. Vendor shall prepare NTAMC signal list and submit the same for approval during detail engineering.
2. Verify that approved drawings (printed and soft copies) of all assembled equipment are present.
3. Verify that the detailed signal list for Local SAS and NTAMC SCADA as per POWERGRID specimen signal list is available with IEC 61850 & IEC 60870-5-104 addresses and display text as per the list.
4. Verify that the detailed GOOSE matrix with publisher and subscriber details is available.
5. Verify all required hardware and software manuals are present.
6. Guaranteed Technical Particulars (GTPs) as approved by POWERGRID are included in Appendix A for reference.
7. A copy of Customer Technical Specification for reference is made available in the FAT room.
8. Availability of the approved Drawing list in the FAT room.

Drawing Verification Log:

Sl No.	Description	Drg No.	Checked
1	Standard Approved MQP		☐
2	Approved FAT Procedure		☐
3	GTP-Guaranteed Technical Particulars		☐
4	Complete SAS Architecture Standard General Technical Particulars for SAS		☐
5	Hardware specification		☐
6	Approved HMI Signal List		☐
7	Approved NTAMC Signal List		☐
8	Approved IP address List as received from POWERGRID		☐
9	Functional Design Specification		☐
10	Exported HMI signal list file in spreadsheet/CSV format.		☐
11	Exported NTAMC signal list file in spreadsheet/CSV format.		☐
12	VLAN Architecture drawing (If applicable)		☐
13	Matrix for GOOSE messages for each feeder (with publisher& subscriber details, Mac id, APP Id, VLAN as required)		☐
14	Matrix for SV (with publisher & subscriber details, SV ID, Destination mac and VLAN details) in case of Process Bus substation		☐
15	Ethernet Network Configuration Document (RSTP details, VLAN details, Port details etc.)		☐
16	IP Addressing as per Submitted Architecture (by Vendor) based on sr.no.9		☐
17	Single SCD File of the entire substation		☐
18	GA & Scheme of Network Panel(HMI/Gateway/Time sync/DR)		☐
19	Aux BCU Panel		☐
20	CRP (Line/Trafo/BR/LR/BB/BC/TBC/TieEtc)		☐
21	Product Manuals (Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)		☐
22	Control Room Lay-out		☐
23	Switchyard Panel Room layout drawing		☐
24	Bill of Quantity-Spares		☐
25	Operation and Technical Guide for BCU, Gateway, Server, OWS Software		☐
26	Operation and Technical Guide IED configuration softwares		☐
27	Operation and Technical Guide NMS Software		☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Sl No.	Description	Drg No.	Checked
28	Operation and Technical Guide Ethernet Switch		☐
29	Operation and Technical Guide Time synchronizing Equipment		☐
30	Operation and Technical Guide Router Cum Firewall		☐
31	Operation and Technical Guide UPS/Inverter		☐
32	**Other applicable drgs (not listed above)**	**Attach the list as annexure**	☐

Note: A single SCD file shall be there for the entire substation. For extension projects too, the SCD file shall be a single file after integrating the newer IEDs.

2.2. SAS FAT EQUIPMENTS

For the FAT configuration the following equipment will be present:

Computer type:	Quantity (complete SW installed)				
(Make e.g., Advantech)	Engg./DR PC	Server PC	Client/HMI PC	Gateway PC	Sys log PC
(Model)					

Network components:	Quantity			
	Station Level		Bay/Dia Level	
	Make/Model	Nos.	Make/Model	Nos.
Ethernet Switch				
GPS Time server				
Router cum Firewall				
Networking Panel				
Auxiliary BCU Panel				
Protection & Relay Panels	NA	NA		

Peripheral	Quantity	
	Make/Model	Nos.
Event Printer		
DR Printer (Color)		
Logbook Printer		
Auto-Changeover switch for redundant UPS supply		
UPS (5 kVA)		

Note: These equipment quantities shall be verified w.r.t. Engg. approved SAS Architecture and BOM.

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Name:	Name:
Date:	Date:

S.NO.	IEDs	Used For Functions	IED Make	IED Model	Quantity
1.	Main-1 Distance Relay	21M1			
2.	Main-2 Distance Relay	21M2			
3.	Transformer Diff. Relay	87T			
4.	Transformer REF Relay	64			
5.	Reactor Differential Relay	87R			
6.	Reactor REF Relay	64R			
7.	Bay Control Unit	BCU			
8.	BB Diff. Relay	87CU/MCU			
9.	Peripheral Unit	87PU/ BU			
10.	LBB Relay	50BF			
11.	Backup Impedance Relay	21R			
12.	Master Trip relay	86A/B			
13.	Auto-reclose Relay	79			
14.	Stand-alone DR	21DR			
15.	TEED Differential Relay				
16.	Controlled Switching Device				
17.	Transformer B/U O/C				
18.	RTCC				
19	SAS Spare Equipments				
	Other applicable equipments (not listed above)				

Notes:
1) All Units should be present with loaded configurations

For an overview drawing of the equipment installed for the FAT please refer to the sec. **2.1.1.**

POWERGRID Representative	**Manufacturer Representative**
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

3. STATION LEVEL EQUIPMENT

Software and hardware components are checked to ensure required functionalities. Versions are recorded for later support purposes.

3.1. HARDWARE COMPONENT

The following hardware equipment are to be present during FAT:

- All Bay Control Units as per approved BOQ.
- All Protection Relays as per approved BOQ.
- HMI/Redundant HMI system consisting of redundant servers.
- Time Synchronizing Equipment consisting of GPS Receiver Unit, Antenna, Time Display Unit.
- Substation Controller/Gateway Subsystem
- Color Printer
- LAN switch equipment
- Auxiliary Panel
- UPS

The above equipment are to be as per approved standard GTP

Purpose

To verify that all hardware equipment required in the contract are available in the FAT room for testing.

Procedure

1. Visually inspect units and individual modules for cleanliness and ensure that they are free from damage.
2. Visually inspect the units for correct wiring practices and ensure that they are free from insulation damage.
3. Ensure the equipment is configured for proper point capacity as per approved drawings.
4. Ensure all modules, terminations and cables have the proper location labels as per approved drawings.
5. Ensure that all earth ground and shield connections are correctly bonded in the panels.
6. Ensure all equipment is free from all foreign material (Dust, Solder, droppings etc.)

Hardware Visual Inspections Log:

S.NO.	Equipment	Hardware Specification (CPU/RAM/HDD)	Serial No.	Checked
1	Server Workstation-1			☐
2	Server Workstation-2			☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

S.NO.	Equipment	Hardware Specification (CPU/RAM/HDD)	Serial No.	Checked
3	Operator Workstation-1 with speakers			☐
4	Operator Workstation-2 with speakers			☐
5	Gateway #1			☐
6	Gateway #2			☐
7	Disturbance Recorder PC			☐
8	Sys Log PC			☐
9	Station Ethernet Switch			☐
10	Router Cum Firewall			☐
11	Color Laser JET Printer			☐
12	Dot Matrix printer			☐
13	GPS Receiver Unit			☐
	Other applicable equipments (not listed above)			

Panel Visual Inspections Log:

S.NO.	Equipment	Serial No.	Circuit Name	Quality of Wiring	Checked
1.	Networking Panel		Networking Panel		☐
2.	Aux. Panel		Aux. Panel		☐
3.	Inverter				☐
4.	Modem				☐
5.	----				☐
6.	----				☐
	Other applicable Panels (not listed above)				☐

3.2. SOFTWARE COMPONENTS

The Software to be used will include the following applications/capabilities:

- The BCU/IED with IEC 61850 (Server/Client) capability.
- HMI & Server with latest Version with IEC 61850 (Client) capability.
- Gateway with latest Version with IEC 60870-5-101 & 104 capability.

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Signature:	Signature:
Name:	Name:
Date:	Date:

Configuration files shall be downloaded prior to commencement of tests and shall be the actual configuration files for individual S/S.

3.2.1. FIRMWARE VERIFICATION

Purpose
To verify and record that the Equipment Firmware used in the FAT.

Procedure
Using Device Display verify all BCU/IED equipment firmware version.

Firmware Verification Log.

S.NO.	Equipment	Model	Operating System/Firmware	Checked
1	OWS-1 & 2			☐
2	SERVER 1 & 2			☐
3	Gateway-1&2			☐
4	DR PC			☐
5	Ethernet Switches			☐
6	Firewall Cum Router			☐
7	GPS Receiver			☐
8	Color Laser JET Printer			☐
9	Dot Matrix Printer			☐
10	Voltage Level_BCU_BAY No.			☐
11	Voltage Level IED's (IEC61850 Compliant) for Dia			☐
	Other applicable equipments (not listed above)			

Note: Record all the TCP/IP Devices & IED devices(Protection, BCU, CSD, RTCC,etc) model & Firmware version which are connected in the substation

3.2.2. IP ADDRESS VERIFICATION

SCADA Devices - IP Addresses
IP address has to be kept as per the list provided shared by POWERGRID. This should be checked at each device user interface.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Station level equipment:

Designation	N/W Name	Mac Id	IP Address				Checked
SERVER 1			172	16	55	1	☐
SERVER 2							☐
OWS1							☐
OWS2							☐
EWS/DR PC							☐
SDC1(If Applicable)							☐
SDC2(If Applicable)							☐
GATEWAY1							☐
GATEWAY2							☐
GPS Time Server 1							☐
GPS Time Server 2							☐
Ethernet Switch 1							☐
Ethernet Switch 2….n							☐
Event Printer							☐
Color Laserjet Printer							☐
Router cum Firewall 1							☐
Router cum Firewall 2							☐
Other applicable equipments (not listed above)							☐

Protection & Control IEDs:

RELAY'S NAME	N/W NAME	GOOSE ID	IP Address				Checked
P444_-------Line			172	16	55	1	☐
							☐
							☐
							☐
							☐

Note: Record all the TCP/IP Devices & IED devices (Protection, BCU, CSD, RTCC,etc) model & Firmware version in the substation

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

4. TEST EQUIPMENT PREPARATION

The following equipment is required to conduct the test.

- EWS/DR PC installed with all configuration application of IEDs utilized in the project.
- SAS server-1 &2 installed with required SCADA & other softwares as required.
- Gateway -1&2 installed with required SCADA & other softwares as required.
- NMS software installed in the DR PC
- Ethernet switch configured with Proper VLAN, Bridged priority, Edge port and managed as required and documented properly wherever applicable.
- Hand-held Digital Multi-meter suitable for AC/DC with peak-hold and continuity tester
- Digital Clamp-on Meter suitable range for secondary current measurement
- Three phase injection KIT (Relay Test Kit) for supplying 3 phase current and voltage.
- 4-20 mA Injection Kit
- Protocol Analyzer & simulator as applicable (IEC 101/104, Wireshark & etc)

4.1. TEST EQUIPMENT INSPECTION

Purpose

To ensure that the Test Equipment to be used is operational and has valid calibration.

Procedure

Visual inspection of calibration stickers and certificates. Power up and verification that units are operational.

Test Equipment Inspection Log:

S.NO.	Equipment	Calibration Check	Device Power On	Checked
1	3 Phase Injection Kit			☐
2	Precision Hand-held Digital Multi Meters			☐
3	Digital Clamp-on meter			☐
3	Insulation Resistance Tester			☐
4	220V DC Source for powering up all SAS Panels			☐
5	4-20 mA Injection Kit			☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

4.2. POWER CHECKS

Purpose

To ensure that the SAS equipments installed in the panels & control rooms are operating when connected to the nominal specified power supply (220 V AC/DC).

Setup/Program

Perform the steps below to confirm correct operation of all equipment connected to the power supplies.

Procedure

1. Verify that all 220V AC/DC equipments are powered at the nominal AC/DC supply voltage input. Using a Digital Multimeter verify that the nominal AC/DC supply voltage is present.
2. Verify that there are no abnormalities seen when the equipment are turned ON.

Power Checks Log:

S.NO.	Panel	Equipment	Device Power ON	Checked
1	NA	Server-1		☐
2	NA	Server-2		☐
3	NA	HMI-1		☐
4	NA	HMI-2		☐
5	NA	DR PC		☐
6	NA	Gateway-1		☐
7	NA	Gateway-2		☐
8	NA	Laser JET Printer		☐
9	NA	Dot Matrix Printer		☐
10	Networking Panel	Auxiliaries (Lighting etc), LAN Switches, Gateway		☐
11	Relay Panel	Relays and Wiring diagram		☐

5. FUNCTIONAL TESTING

General Substation Automation System (SAS) is a combination of different bay control units and protection devices with a central operator placed as Human-Machine-Interface (HMI) and central data storage and acquisition. These components and its connections are shown in the System Architecture. For SAS-FAT configuration is selected to check

the basic system functions and the co-operation between the different components. The test procedure will show the proper function of the system in general. All decentralized I/O devices (bay control units and protection devices) are provided for this test. A complete test of all I/O signals (see SAS signal list) is the objective of this test. All modules are tested by type tests in general and by test routines during manufacturing.

5.1. START-UP BEHAVIOR AND SAS SYSTEM AVAILABILITY

For the following equipment the start – up times are measured to check the performance. The timing of the station controllers starts with switching on the power supply and finishes after reaching the working condition "RUN". The timing of the Operator Workstation starts with switching on the power supply. The computer will then start - up automatically without registering to Windows or manual start of any software. The timing finishes after reaching the start picture of the application software where the user has to register with the password. The timing of the Engineering PC and Protection Interface PC starts with switching on the power supply and finishes after successful achievement of the working condition.

Note: This test has to be done when all bays along with all signals have been configured and the same are reporting in HMI.

System Start-up	Checked	Start up Time	Comments see log sheet no.
Server-1 (Switch on the relevant MCB Server-1 Workstation boots up and SCADA starts automatically)	☐		
Server-2 (Switch on the relevant MCB Server-2 Workstation boots up and SCADA starts automatically)	☐		
Operator Workstation 1 (Switch on the relevant MCB OWS-1 Workstation boots up and SCADA starts automatically)	☐		
Operator Workstation 2 (Switch on the relevant MCB OWS-2 Workstation boots up and SCADA starts automatically)	☐		
Engineering/DR PC (Switch on the relevant MCB Engineering Workstation boots up and NMS starts automatically)	☐		
Gateway 1 (Switch on the relevant MCB Gateway-1 Workstation boots up and SCADA starts automatically and Data Transmission to RCC/RLDC should resume automatically)	☐		Data Transmission to NTAMC/RCC/RLDC should resume automatically
Gateway 2 (Switch on the relevant MCB	☐		Data Transmission to NTAMC/RCC/RLDC should resume automatically

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Gateway-2 Workstation boots up and SCADA starts automatically and Data Transmission to RCC/RLDC should resume automatically)			
Complete system start up	☐		Black Start

Time Synchronization Verification

After start-up of all devices the error free operation, communication and time synchronization of components is checked on the SCADA displays.

S.NO.	System Start-up	Checked
1.	Time synchronization of Substation controllers / PCs	☐
2.	Time synchronization of connected IEDs	☐
3.	Communication to Bay Control Unit	☐
4.	Communication to Protection Devices	☐
5.	Event list printer	☐
6.	Hardcopy color/ Logbook printer	☐
7.	Communication with remote control centres	☐

5.2. MONITORING AND CONTROL

5.2.1. BCU – DISPLAYS AND HANDLING.

General layout, handling and control of typical feeder BCUs is demonstrated and checked under this chapter. The displayed SLD is cross checked against the approved SLD/ Mimic SLD.

BCUs for__kV Level	Checked	Comments see log sheet no.
Basic/control display for OHL FEEDER	☐	
Basic/control display for TRANSFORMER FEEDER	☐	
Basic/control display for LINE REACTOR FEEDER	☐	
Basic/control display for BUS REACTOR FEEDER	☐	
Basic/control display for TIE BAY/TBC	☐	
Basic/control display for AUXILIARY System	☐	
Basic/control display for BUS COUPLER	☐	
Basic/control display for BUS SECTION	☐	
Event list	☐	
Alarm list	☐	
Analogue measurement list	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

BCUs for__kV Level	Checked	Comments see log sheet no.
Metering list	☐	
Alarm limits	☐	
Handling of displays, control and menu	☐	
Changing V,I,f – limits: - current >limit 1 - current >limit 2 - voltage >limit 1 - voltage <limit 1 - frequency >limit 1 frequency <limit 1	☐	
BCUs for__kV Level	☐	

5.2.2. HMI – USER ADMINISTRATION & ACCESS RIGHTS

Access rights form the basis for safety and security of the overall system with restricted access boundaries for monitoring, control as well as access to specified applications. Access rights are allotted via usernames with password authentication.

Complete flexibility allows for authorization across various screens for viewing access, specific application access, down to individual switching device operation access.

A multi-level login Active directory is implemented in SCADA. There are 4 different levels of access. Without login, there is no possibility to open any display. The different access levels are implemented as shown in following table:

Purpose

To verify that the OWS & HMI system has Security Classes, that are enabled and configured properly.

Setup

- Ensure that the HMI Servers are running.
- Ensure that OWS PCs are running.
- Ensure that PCs are connected to the Network.

Procedure

1. Start Client, by default the user will be logged in as Blank.
2. Verify that this user class has proper access level as per HMI Security Classification.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

3. Go to any bay detail screen. Verify if access to tool bar and object controls are according to that allowed in the access level logged in.
4. Repeat steps 1 to 3 for the other HMI Usernames (Operator, Engineer, Administrator)
5. Repeat steps 1 to 4 for the other Workstations (OWS-1 &2, Server-1&2, Gateway-1&2)
6. Function is tested by clicking on the corresponding buttons or switching devices and checking of SCADA “No permission” – notifications.

HMI Access Level:

Access Level	Monitor	Operator	Engineer	Admin	Checked	Comments see log sheet no.
Display System Status & View Screens	Yes	Yes	Yes	Yes	☐	
Controls – CB, Isolators	No	Yes	Yes	Yes	☐	
Acknowledge/Clear Alarms	No	Yes	Yes	Yes	☐	
Change HMI Config.	No	No	No	Yes	☐	
Create/Disable/Delete User Account	No	No	No	Yes	☐	
Change User Profile/Access Level	No	No	No	Yes	☐	
Maintenance mode	No	No	Yes	Yes	☐	
Reset lockout relay	No	Yes	Yes	Yes	☐	
Interlocking bypass	No	No	Yes	Yes	☐	
Sync. Check Bypass	No	No	Yes	Yes	☐	
Auto-reclosure	No	No	Yes	Yes	☐	
Auto sequence	No	No	No	Yes	☐	
Shut down the system	No	No	Yes	Yes	☐	

Automatic Logout

Verify Automatic Logout after 30 min idle time is provided for all access rights.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

5.2.3. HMI – DISPLAYS AND HANDLING

Check that the displays are in accordance with POWERGRID requirements. General layout and handling are demonstrated and checked. Overview and control pictures are cross-checked against the approved substation SLD.

Purpose

To verify that the Single Line Diagram and Bay Detail Screens on the OWS/HMI system are configured properly and are in correct operating condition.

Setup

1. Ensure that the HMI Servers are running.
2. Log in as an “Operator”.

Procedure

1. Verify the layout of each SLD on the OWS/HMI.
2. Verify the device number, device description and device symbol for each device.
3. Verify all displayed analog and digital values on the detailed bay view screens.
4. Click on each device object and confirm that the respective popup screen or bay/view detail screen is displayed.
5. Repeat steps 1 to 4 for each SLD / Detailed Bay View.

HMI Screen Verification	Checked	Comments see log sheet no.
Handling of screen/picture selection	☐	
Display for Station overall SLD	☐	
Display for__kV overview:	☐	
-_____kV substation overview	☐	
-_____kV single line diagram view	☐	
Display for__kV overview:	☐	
-_____kV substation overview	☐	
-_____kV single line diagram view	☐	
Display of Operations counter for PLCC, CB, LA	☐	
Auxiliary LVAC view & control	☐	
Firefighting system Signals View & control	☐	
Auxiliary DC system view	☐	
Display of Measurement Trends (Real-time and Historical)	☐	
Display of maintenance mode	☐	
Display of safety tagging	☐	
Display of Network/LAN overview	☐	
Display of typical bay communication (Ring)	☐	
Display of event list	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

HMI Screen Verification	Checked	Comments see log sheet no.
Display of alarm list	☐	
Handling of screen/picture selection	☐	
Basic/ Control display for Kiosk Air Conditioning System	☐	
Basic Control display for Online monitoring System for Transformers & Reactors	☐	
Basic /Control display for Control witching Device	☐	
Busbar Colouring as per Live condition	☐	
CVT/CT Monitoring	☐	
Transformer Bank with Tap changer Operation	☐	
Bay Authority level to be checked from Local/Remote/Station/RCC	☐	
Busbar Colouring for the dynamic voltage changes	☐	

Note- In case of extension/Augmentation packages, the existing make SCADA system of the substation where extension is proposed shall be used to carry out the validation of extension bays signals, control commands, etc., with the extension bays configured as the only bays that exist in the substation. For this purpose, the existing SCADA system can be installed on a laptop. Further after completion of FAT, the verified SCADA configuration shall be used for addition into the existing SCADA at site.

5.2.4. INSPECTIONS OF HMI TYPICAL BAY SCREENS

Validation of electrical views

Purpose

To verify that the Single Line Diagram and Bay Detail Screens on the OWS/HMI system are configured properly and are in correct operating condition.

Setup

1. Ensure that the HMI Servers are running.
2. Log in HMI/OWS as an “Operator” .

Procedure

1. Verify the layout of each SLD on the OWS/HMI.
2. Verify the device number and device description for each device.
3. Verify all displayed analog and digital values on the detailed bay view screens.
4. Click on each device object and confirm that the respective popup screen or bay/view detail screen is displayed.
5. Repeat steps 1 to 4 for each SLD / Detailed Bay View.

Bay screens_____kV	Checked	Comments see log sheet no.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

(Naming, SCADA numbers, status indications,measurement items to be checked)		
_____kV LINE FEEDER	☐	
_____kV TRANSFORMER FEEDER	☐	
_____kV BUS REACTOR	☐	
_____kV LINE REACTOR	☐	
------	☐	
--------	☐	
Bay screens_____kV (Naming, SCADA numbers, status indications,measurement items to be checked)	**Checked**	**Comments see log sheet no.**
_____kV LINE FEEDER	☐	
_____kV TRANSFORMER FEEDER	☐	
_____kV SHUNT REACTOR	☐	
_____kV BUS REACTOR	☐	

Note:

1. **Verify Controlling of each equipment and status of changes.**
2. **Verity that SW interlock – Normal/Bypass**
3. **Safety Tagging for each bay checking**
4. **AR ON/OFF command checking**
5. **CSD IN/OUT checking**
6. **86 Reset/Operated checking**
7. **CB 3 Pole & single pole checking**

5.2.5. GIS GAS MONITORING VIEW

Purpose

In this section we will verify that the GIS Gas Monitoring view screen is represented as per requirement and in line with relevant SLDs.

GIS Gas monitoring View verification

Description	Checked
Verify that the “GIS Gas Monitoring view” screen is displayed on the HMI and GSLD in dynamic color in nature.	☐
Verify that the “GIS Gas Monitoring view” is in line with the Gas Compartment scheme.	☐
Simulate SF6 Stage-1 Alarm from BCU & verify it is report as events	☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Description	Checked
Verify that this is detected and is displayed in the view.	☐
Simulate SF6 Stage-2, 3 & 4 Alarm from BCU & verify that this is detected and is displayed in the view and as well as reported as events.	☐
Verify that Gas Pressure is indicated for each compartment (if Applicable)	☐

5.2.6. VALIDATION & VERIFICATION OF SIGNALS ON SCADA HMI/GATEWAY

Purpose

To verify that the signals as per the approved signal list provided by POWERGRID have been correctly configured and are appearing on SCADA HMI/GATEWAY as desired.

Prerequisites for the Validation

1. Approved SCADA Signal list for HMI/Server for Substation level
2. Approved RCC-SCADA Signal list for NTAMC for Gateway
3. Goose signal list (Signals between IED, Mac id, APP id, VLAN) by vendor

HMI/NTAMC SCADA Signal Verification

The Detailed signal list based on which the SCADA configuration has been prepared shall be taken and each signal shall first be validated by simulating “HIGH” and “LOW” states one by one (e.g Naming of each signal, appearance of “Valid”, Reset/ Set/operated/Healthy, etc status as per the appearance of on-screen validity shall be checked). Any signal appearing as “unknown” / “invalid” shall be flagged and configuration shall be modified for proper validation.

Typical bays to be created in SCADA configuration for each feeders and any changes in any bays should be reflected in all bays. Signal list for each typical bay must be configured with sufficient spare with each IEDs standard so that changes in any of the Typical should reflect in all the other bays.

After validation of signals under SCADA configuration, various protection functions and appearance of the desired signals on SCADA HMI shall be verified.

For certain signals (having Integer type attribute), the on-screen display of text depends on the value fetched from IED, (e**.g. Auto-reclose status from function RREC wherein the value of AutoRecSt 1 denotes ready, 2 denotes Auto-reclosure in-progress, etc**).

All types of text displays with different inputs shall be verified by simulation of the state and their naming should be configured in user understandable manner. (**e.g. Auto-reclose status from function RREC wherein the value of AutoRecSt 1 denotes ready so text should be “Auto Reclose Ready”, etc**)

Note:

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

1. **For verifying the HMI/SCADA signals for each bays, the simulation may be done from the respective devices. If the devices are not available due to unavoidable situation, same may be done using the Simulators like Omicron Scout, IEC browser etc.**
2. **For extension/Augmentation projects, The existing project typical has to be taken as reference and configuration has to be done accordingly to reflect the existing projects signal name & appearance.**

GATEWAY DATABASE CONSISTENCY CHECKS

There are three IEC-104 ports on each Gateway for communication with NTAMC, Backup NTAMC & RTAMC Control Centers. Reporting of all signals is required to checked on all six ports through database consistency checks as per the procedure below.

IEC Master Simulation Software is to be connected on each port one by one and data is to be polled through General Interrogation. Output from all six ports consisting of all data points with IEC-104 address and ASDU to be dumped in an excel file and to be checked for count of signals with identical reporting. Mismatch if any between all six ports to be rectified.

After successful completion of this test, no modification of database is allowed.

Description	Checked	Comments see log sheet no.
Gateway Database Consistency Final Database Version_____	☐	

Host firewall of remote gateways shall be enabled and configured as per baseline configuration.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Control Authority Transfer Signal Verification:

For Main System:

	STATUS- MAIN CONTROL ON NTAMC	STATUS - MAIN CONTROL ON RTAMC	STATUS - MAIN CONTROL ON BNTAMC	CHECKED	Comments see log sheet no.
COMMAND FROM SCADA FOR MAIN SYSTEM CONTROL AT NTAMC	**SET**	**RESET**	**RESET**	☐	
COMMAND FROM SCADA FOR MAIN SYSTEM CONTROL AT RTAMC	**RESET**	**SET**	**RESET**	☐	
COMMAND FROM SCADA FOR MAIN SYSTEM CONTROL AT BNTAMC	**RESET**	**RESET**	**SET**	☐	
DEFAULT STATUS	**SET**	**RESET**	**RESET**	☐	

For Auxiliary System:

	STATUS- AUX CONTROL ON NTAMC	STATUS -AUX CONTROL ON RTAMC	STATUS -AUX CONTROL ON BNTAMC	CHECKED	Comments see log sheet no.
COMMAND FROM SCADA FOR AUX SYSTEM CONTROL AT NTAMC	**SET**	**RESET**	**RESET**	☐	
COMMAND FROM SCADA FOR AUX SYSTEM CONTROL AT RTAMC	**RESET**	**SET**	**RESET**	☐	
COMMAND FROM SCADA FOR AUX SYSTEM CONTROL AT BNTAMC	**RESET**	**RESET**	**SET**	☐	
DEFAULT STATUS	**SET**	**RESET**	**RESET**	☐	

Buffer Synchronization between Main and Standby Gateway:

Substation Gateways are to be configured in Hot-Hot mode i.e. all six remote communication ports are always ready for transmitting data to the master stations (Main NTAMC, Backup NTAMC, RTAMC). At an instance, each control center polls only one of the gateway independently. During gateway switchover from control center, it is to be checked that the signals which have been reported in real time from previous gateway should not report again as buffer event from second gateway. Buffer signals must be synchronized between both gateways.

	Buffer signals reporting	CHECKED	Comments see log sheet no.
Check Signals reported in real time at SCADA from main gateway and switching over to Standby Gateway (Check for each Master one by one)	Previous event already reported by Main Gateway should not report from Standby Gateway buffer	☐	
Check Signals reported in real time at SCADA from Standby gateway and switching over to Main Gateway (Check for each Master one by one)	Previous events already reported by Standby Gateway should not report from Main Gateway buffer	☐	
Check Signals reporting from buffer after restoration of the link with master station (Check for each master one by one from both gateways)	Previous event should report as buffer as per buffer event capacity	☐	

GOOSE Signal Verification

For all the IEDs subscribing to GOOSE messages from other IEDs (e.g. BCUs, Protection), which are used to perform logical actions, the appearance of **GOOSE fail / GOOSE trouble alarm** shall be configured and verified by making one of the GOOSE message absent, to which the IED subscribes. **(Note: Wherever GOOSE messages configured should be ensured with quality tag configured and failure of the GOOSE signal should reflect in respective subscribed IED as invalid, and alarm appears in SCADA).**

The Voltage selection logics for ICTs & Rector feeders, utilizing GOOSE messages shall also be verified by simulating various switchgear status, which change the selected voltage.

Note:

1. **Each GCB of the IEDs has to be verified for every device for the VLAN, App id, Mac id as per the Goose Signal list documentation. Unused GCB/RCB may be may be removed.**
2. **Wherever available, GOOSE supervision shall be done using LGOS Logical node.**
3. **GOOSE dashboard may be prepared in HMI for easy monitoring of GOOSE reception for process bus/digital substation.**

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

5.2.7. VALIDATION OF HISTORICAL TREND

Purpose

To verify that the Trend in the OWS/HMI system are configured properly and are in correct operating condition.

Setup

Ensure that the HMI servers are running. Go to Trend Screen.

Validation of Historical Trend on OWS/HMI

S.No.	Activity	Checked
1	Verify all Analog signals on trend screen for each feeder configured.	☐
2	Verify that the trend curve on HMI screen for different analog signal has different colors.	☐
3	Verify that the Time Scale for trend curves are user settable.	☐
4	Verify that EHV Lines/ ICT/Reactors/Bus/ LVAC have Predefined trend of current, active and reactive power. Bus have Predefined trend of voltage and frequency.	☐
5	Data archive retrieval is to be checked for proper display of old records	☐

5.2.8. VALIDATION OF REPORTS FUNCTION

Purpose

To verify that the Reports Functions (Historical Report) in the OWS/HMI system are configured properly and are in correct operating condition.

Setup

1. Ensure that the Client & Server is running.

Historical Event Report

1. Generate some Digital / Analog events in BCU.
2. Click on the Reports button present on the HMI/OWS Screen.
3. Select the Range of date by selecting the Start Date and End Date.
4. Verify whether the same generated events have been produced in the Historical Report.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Daily Report (Hourly Instantaneous Value of Analog Data Points)

1. Inject Voltage & Current through 3 Phase Injection Kit to any BCU.
2. Verify the values on the detailed view of the selected BCU.
3. Select the daily Report Button of line BCU.
4. Verify the daily Report have produced Hourly instantaneous Value of the selected BCU. The Maximum and minimum instantaneous value of each selected parameter (with time) shall also be included in the report. This time-tagged max and min data shall be generated from the Trend data of the BCU.
5. Data archive retrieval is to be checked for proper display of old records.

Operation Reports:

Apart from Historical and trend reports of analog values, reports in specified formats as per the requirement of POWERGRID system operation is also to be generated in the standard format provided by POWERGRID. The reports will be periodic logging (15min/01 hourly/ 04 hourly/ 08 hourly etc) of analog/ digital values.

The following reports must be covered as a part of the Reports in prescribed format as per POWERGRID.

1. EHV Feeders (Line, Transformer, Reactor, etc)
2. Transformer Feeder & Reactor Temperatures
3. Online Monitoring equipment values
4. LV System – AC switch board values
5. Kiosk Temperatures
6. Battery charger
7. PLCC/DTPC Counter readings
8. Circuit breaker counter recordings
9. LA counter recordings

5.3. SCADA COMMUNICATION

In this chapter the communication to SCADA via IEC101/IEC104/IEC 61850 will be checked. A detailed information test (control authority, commands, and indications) will be done in the chapter following this. SCADA-interface is simulated with test program IEC-Test running on two laptops. With the test program the protocols IEC-101/IEC-104 as well as IEC-61850 can be simulated. Detailed redundancy tests will be performed under **chapter 5.17.**

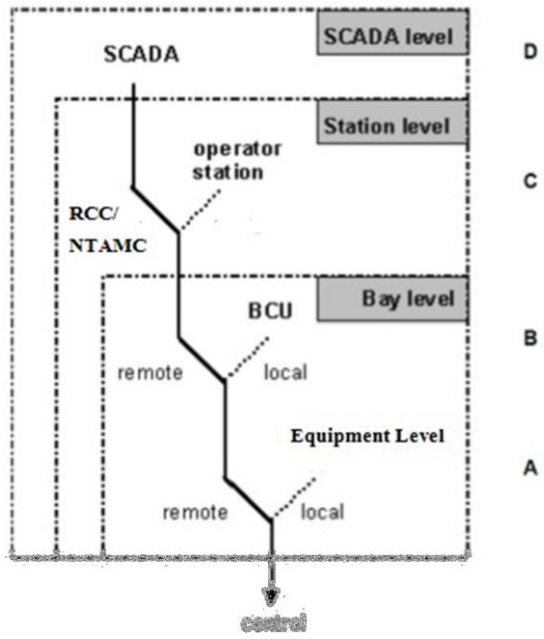
	Checked	Comments see log sheet no.
Communication checks for -spontaneous information -general interrogation	☐	
- time stamping of indications	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

- **Check response/ refresh time of reporting any data from IED**	☐	

5.4. CONTROL TESTS

Control is possible from Control Panel/LCC Board, BCU, Operator Workstation (1 or 2) and NTAMC/Backup NTAMC/RTAMC. During the test all check back indications from switchgear devices will be simulated by an I/O simulation box. Preconditions for controls are correct switching conditions (synch-check and interlocking). Switching the relevant local/remote switch will be displayed in the event list.



	Checked	Comments see log sheet no.
A. Control from mimic board The mimic board is implemented in the cubicle	☐	
B. Control from BCU Changing the status of local/remote switch on BCU raises an event-on-event list. Control from BCU is only possible if local/remote switch on. BCU is in local position and local/remote switch on mimic board is in remote position. In this position no control from Operator Workstation and SCADA is possible.	☐	
C. Control from Operator Workstation Changing status of local (SCADA) / remote (SCC/RCC) button on Software screen raises an event-on-event list. Control from Operator Workstation is only possible if control is switched to local position and local/remote switch on BCU in Remote and mimic board is in	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

	Checked	Comments see log sheet no.
remote position. In this position no control from SCC/RCC is possible.		
D. Control from SCC/RCC Control from SCC/RCC is only possible if all local/remote switches per bay (on bay- and station level) are in remote position and Local SCADA in Remote position. SCC/RCC interface is simulated with test program IEC Test.	☐	

5.5. CONTROL METHOD

Control of switchgear shall be done from the detailed bay display diagrams in OWS/HMI. The method of man machine dialogue shall be a multi-stage procedure with verification to ensure security of control.

	Checked	Comments see log sheet no.
- Selection of switching device	☐	
- Appearance of selected device control window	☐	
- Selection of switching direction (open/close)	☐	
-Change of the selected device symbol (flashing in selected control direction)	☐	
- Execution of the control	☐	
- Possibility of cancellation at any time	☐	
- Time out of control mode if operator fails to respond	☐	
- Bypassing the command for interlocking/Synchorcheck wherever required		
- Source of control appearance in event list	☐	
- Double object control blocking function for control from HMI/ SCADA level	☐	

5.6. CONTROL OF DUMMY CIRCUIT BREAKER

	Checked	Comments see log sheet no.
- Check of dummy circuit breaker function	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

5.7. CONTROL OF CIRCUIT BREAKER

"CLOSE" and "OPEN" operation of typical circuit breaker is tested by giving a command from BCU or HMI and checking of the command execution. At the same time, the respective check back indication of switching position is checked at the BCU and HMI. The correct registration in the event list will also be tested. All the bays for each voltage level will be checked. Furthermore, some faults will be simulated (e. g. control authority, CMD interlocked, CMD monitoring time). RCC SCADA interface is simulated with test program IEC-Test.

kV Level	Command	Checked typical				Comments see log sheet no.
		701-52	401-52	***-52	***-52	
765kV	Circuit breaker Control/Display BCU Control/Display HMI Control/Display RCC HMI/NTAMC event list	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	
400kV	Circuit breaker Control/Display BCU Control/Display HMI Control/Display RCC HMI/NTAMC event list	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	
-------kV	Circuit breaker Control/Display BCU Control/Display HMI Control/Display RCC HMI/NTAMC event list	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	

5.8. SYNCH-CHECK

Synchro check-function is parameterized in the BCU. Therefore, control is demonstrated from bay control unit for functionality-check. Positions of bus bar voltage transformer disconnecting switch are simulated by an I/O simulation box and bus bar voltage by a test set (e.g., Relay Test Kit).

Purpose

To verify that Incoming and Running (Reference) voltages are within the synchronizing range before the circuit breaker can close. The circuit breaker will not close if any of the limiting parameters is not within the check synchronizing range. For practical reasons this FAT will not include the testing of Running Voltage selection for the Synchronization.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Setup

1. Set up the BCU to check synchronizing ranges as follows:
   - Phase Differences Specification requirement states Phase Difference shall not exceed 30° (1ºHysteresis).
   - Voltage Difference Specification requirement states Voltage Difference shall not exceed 10%(2% Hysteresis).
   - Frequency difference 0.1 Hz (Connected System).
2. Set up the 3 Phase Injection Kit to supply the Running Voltage & Selected Voltage to BCU TMU card(CT/VT card).
3. Set up the 3 Phase Injection Kit to the following test cases:

Check Synchronization Test Settings
Voltage Difference

Test Case	Voltage Difference in pu	Phase Y Difference in Degrees	Expected Sync Close Results	Checked
1	0.20	40.0	No	☐
2	0.12	40.0	No	☐
3	0.10	20.0	No	☐
4	0.09	20.0	No	☐
5	0.09	17.0	No	☐
6	0.10	16.0	No	☐
7	0.10	15.0	Yes	☐
8	0.05	10.0	Yes	☐

Procedure

1. Select a BCU and corresponding Circuit Breaker to Test.
2. Using the 3 Phase Injection kit, inject the Running & Selected Voltage to the BCU and apply the differences as shown in the above table.
3. Open the Detailed view of the selected Bay on the HMI and verify the voltage references.
4. Initiate the CB Close Request.
5. Verify that the Circuit Breaker closes only when the configured settings are satisfied.

CB	CB Condition	Checked
765KV Circuit Breakers		
701		☐
702		☐
---		☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

400KV Circuit Breakers		
401		☐
402		☐
---		☐

The above check sync verification is to be carried out for all possible voltage selection logics for synchronization (e.g, for main bay breaker connected to Bus 1 in one and half scheme, Bus 1 Voltage- Bus 2 Voltage, Bus 1 Voltage - Feeder 1 Voltage, Bus 1 Voltage – Feeder 2 voltage, as may be required in the scheme). These possible voltage selection conditions are required to be simulated either by simulated switchgear or by simulating GOOSE messages published by other BCUs, which are required in the selection logic.

Synchro-check & Synchronism Check

Purpose

To verify that when the following conditions are met, the Synchro-check logic permits the Immediate closure of the Circuit Breaker.

- **Dead Line-Dead Bus**
- **Dead Line-Live Bus**
- **Live Line-Dead Bus**
- **Live Line- Live Bus**

Setup

1. Set up the BCU to check synchronizing settings as follows:

- Presence of Line Voltage (Param1) – 70%
- Absence of Line Voltage (Param2)– 20%
- Presence of Bus Voltage (Param3)– 70%
- Absence of Bus Voltage (Param4)– 20%

Procedure

The absolute values of the two voltages (V_{line} V_{busbar}) must be above or below settable thresholds, to permit the circuit breaker closing. The following voltage controls are available:

- ✓ **V_{line}- No Voltage** and **V_{busbar}- No Voltage** – (Dead Line-Dead Bus)
- ✓ **V_{line}- No Voltage** and **V_{busbar}- Healthy Voltage** – (Dead Line-Live Bus)
- ✓ **V_{line}- Healthy Voltage** and **V_{busbar}- No Voltage** – (Live Line-Dead Bus)
- ✓ **V_{line}- Healthy Voltage** and **V_{busbar}- Healthy Voltage** – (Live Line-Live Bus)

With **Healthy V_{line}** and **Healthy V_{busbar} TRUE** if the measured voltage is above the threshold V> (param 1 and param 3), and **No voltage V_{line}** and **No voltage V_{busbar}**

TRUE if the measured voltage is below the threshold V< (param 2 and param 4). These thresholds are given in % of the nominal voltage value, updated at CT/VT board level.

The selection of the voltage control is made during the configuration phase.

Test Case	Description	Expected Sync Close Results	Checked
DL-DB	In case of the absence of both voltages i.e. **Vline- No Voltage** and **Vbusbar- No Voltage**	Yes	☐
DL-LB	In case of the absence of one of the two voltages i.e. **Vline- No Voltage** and **Vbusbar- Healthy Voltage**	Yes	☐
LL-DB	In case of the absence of one of the two voltages i.e. **Vline- Healthy Voltage** and **Vbusbar- No Voltage**	Yes	☐
LL-LB	In Case of the presence of both voltages i.e. **Vline- Healthy Voltage** and **Vbusbar- Healthy Voltage** Set beyond ranges	No	☐
LL-LB	In Case of the presence of both voltages **Vline- Healthy Voltage** and **Vbusbar- Healthy Voltage** Set within synchronism ranges	Yes	☐

	Checked	Comments see log sheet no.
Displaying and Handling- BCU	☐	
Displaying and Handling- HMI	☐	

	Checked	Comments see log sheet no.
Live line – dead bus	☐	
Dead line – live bus	☐	
Dead line – dead bus	☐	
Live line – live bus with fulfilled sync	☐	
conditions (Vdiff, fdiff, angle)	☐	

5.9. CONTROL OF ISOLATOR AND EARTHING SWITCH

"CLOSE" and "OPEN" operation of high voltage switching devices are tested by giving a command from BCU or HMI and checking of the command execution. At the same

time, the respective check back indication of switching position is checked at the BCU and HMI. The correct registration in the event list will also be tested. All bay for each voltage level shall be checked. Furthermore, some faults will be simulated (e.g. control authority, CMD interlocked, CMD monitoring time). NCC/RCC-interface is simulated with test program IEC-Test & event list also recorded.

SCADA-interface is simulated with test program IEC-Test wherever required.

5.10. INTERLOCKING (BAY AND STATION BASED)

Control of switchgear devices is only possible if all interlocking conditions are fulfilled. Interlocking conditions are shown in circuit manuals of local control cubicles (For drawing nos. see chapter 2.1). Generally, for demonstration of interlocking the control can be done from bay control unit. As the complete feeder interlocking is checked during SAT of BCU together with primary switchgear, only some selected general functions are shown. Positions of relevant breakers/isolators are simulated by a hardwired I/O simulation box. **The interlocking logic and status for each switchgear should be visible to the operator on OWS/HMI beforehand while operating the respective switchgear.** The validation of interlock condition shall be performed based on the interlock logic visible on the screen.

	Checked	Comments see log sheet no.
Maintenance mode	☐	
Switchgear interlocking	☐	
HMI–display of interlocking conditions along with signals for each switchgear device	☐	

5.11. SWITCHING SEQUENCES FOR GIS (IF APPLICABLE)

Switching sequences are initiated and controlled from the Station Controller. The preconditions for switching sequences are parameterized in BCU. The interruption of the switching sequence can occur due to missing one of the preconditions, either synch-check or interlocking. Correct switching and the corresponding feedback indications will be checked. Randomly, some interlocking conditions will be done in such a way that the switching sequence will be interrupted. The effect will be that the system will wait for the command running time to terminate. **In the event, a list of negative feedback will be recorded indicating the reason for not executing the command i.e., cause of not executing command.**

CONNECT OHL FEEDER TO BB1:		
closing of Isolators & CB		
CONNECT OHL FEEDER TO BB2:		
closing of Isolators & CB		
DISCONNECT OHL FEEDER (Bay):		
opening of Isolators &CB		
CHANGE BUSBAR:		

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

closing/opening of Isolators		
CLOSE BUS COUPLER :		
closing of Isolators & CB		
OPEN BUS COUPLER :		
Opening of Isolators & CB		

5.12. DIGITAL RTCC FUNCTIONS (IF APPLICABLE)

The Digital RTCC Functions view shows information about the transformer feeder (ICT1-ICTn) of the station. Information about the tap position. Using the control button, a tap position control window will appear. It can be chosen between the automatic and manual mode. The tap position of each transformer feeder can be changed with the top/down slider by using the manual mode. The exit button closes the window.

Properties of Digital RTCC	Checked	Comments see log sheet no.
- Selection of transformer feeder	☐	
- Appearance of selected window	☐	
- Selection of control mode (auto/manual)	☐	
- Send TAP rise/ lower command in manual	☐	
-Checking of Master-Follower/ independent mode	☐	
-Checking of Other RTCC Functions(like WTI,OTI Tempt, Cooler bank events, other configured alarms,etc)	☐	

5.13. EVENT PROCESSING

Events are displayed in chronological order in the event list. All events have date and time tag. Selection of event list on Operator Workstation will show the latest page with the newest event on top and the sorting should be ensured.

Events list should have white background & include all the alarms. . The creation of a reduced list is possible by filter function. Transient conditions (i.e.00/11) will not generate an event, unless a time delay is exceeded it Should be ensured particularly in CB, Isolator, Earth switch & other events where change of events takes in prescribed time to avoid flooding of information.

Purpose

To verify that the Events Points are configured properly and in correct operating condition.

Setup

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

1. Ensure that the HMI Servers are running.
2. Display the Event Screen.

Procedure

1. Select a Digital Input Point from one of the BCUs configured as an Event.
2. Change the state of the Selected Input
3. Verify that an Event is displayed on the Event Screen with proper description and Time Stamp.
4. Time format should be configured as 24hours(hh:mm:ss:000).
5. Acknowledge this alarm.
6. Go to the Event Screen and verify that this alarm is displayed in the list.
7. Verify that the same has been printed on the Dot Matrix Printer.
8. Repeat Steps 1 to 6 for the All the digital Input as per the signal list.

Validation of the Events and Alarm Management on OWS/HMI

S.No.	Activity	Checked
1	Verify that separate logs are available for alarm and events	☐
2	Verify that suitable filters (sorting by date, time etc) are provided for both alarms and events	☐
3	Verify that an Alarm and Event is displayed in the Alarm and Event Screen with proper description and Time Stamp	☐
4	Verify the alarm acknowledgement facility and verify that their display changes in alarm viewer according to the alarm status. Persisting alarm shall be distinguishable from acknowledged alarms.	☐

	Checked	Comments see log sheet no.
Event Processing - BCU - HMI	☐ ☐	
Time tagging - BCU - HMI	☐ ☐	
Filter function- date/time - message group - message text - alarm group	☐ ☐	
Check naming convention of one typical feeder according signal list - hierarchical name - signal name	☐ ☐	

5.14. ALARM PROCESSING

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Alarms are displayed in chronological order in the alarm list. Selection of alarm list on Operator Workstation will show the latest page with the newest alarm on top of the line. Coloring depends on alarms status (**RAISED – RED , CLEARED- GREEN, AND ACKNOWLEDGED- YELLOW).** Acknowledgement of alarms dependents on permissions level (see 2.4.2.2 "HMI – USER ADMINISTRATION & ACCESS RIGHTS)

Purpose

To verify that the Alarms are configured properly and in correct operating condition.

Setup

1. Ensure that the HMI Servers are running.
2. Display the Alarm Screen.

Procedure

1. Select a Digital Input Point from one of the BCUs configured as an Alarm.
2. Change the state of the Selected Input
3. Verify that an Alarm is displayed in the Alarm Screen with proper description and Time Stamp.
4. Time format should be configured as 24hours(hh:mm:ss:000).
5. Acknowledge this alarm.
6. Verify that the same has been printed on the log Printer.
7. Repeat Steps 1 to 6 for the several Digital Input

	Checked	Comments see log sheet no.
Alarm Processing (RED) - BCU - HMI	☐ ☐	
Time tagging - BCU - HMI	☐ ☐	
Filter function- date/time - message group - message text - alarm group	☐ ☐	
Permission of acknowledgement	☐	
Alarm raised: YELLOW FLASHING	☐	
Alarm cleared: GREEN	☐	
Alarm acknowledged: YELLOW	☐	
Alarm list filtering function (Date & Time, Bay No.)	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

5.15. ANALOGUE MEASUREMENT HANDLING

Correct displaying of analogue values is checked on the screens of BCU and HMI. A change of analogue quantity is reported to the SCADA master system. Correct displaying of power flow convention is defined and checked. Measurements will be tested from BCU (in feed by a relay test set) as well as from BCU :

	Checked	Comments see log sheet no.
Displaying of analogue values - BCU - HMI	☐ ☐	
Power flow convention	☐	
Real time trends	☐	

Measurement of each Bay:	**For e.g.**	**Checked**
	CT Ratio: 3000A/1A *	☐
	VT Ratio: 400KV/110V *	☐

Current Measurement								
Injected second. Current	**Expected measured value**	**Dead band**	**Indicated Value**					
			R		**Y**		**B**	
			BCU	**HMI**	**BCU**	**HMI**	**BCU**	**HMI**
0.0A								
0.05A								
0.5A								
1.0A								
1.1A								

Voltage Measurement								
Injected second. Current	**Expected measured value**	**Dead band**	**Indicated Value**					
			R		**Y**		**B**	
			BCU	**HMI**	**BCU**	**HMI**	**BCU**	**HMI**
6.35V								
31.75V								
63.5V								
70V								
110V								

POWERGRID Representative	**Manufacturer Representative**
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Frequency Measurement:							
Injected Frequency	Dead band	48Hz		50Hz		52Hz	
		BCU	HMI	BCU	HMI	BCU	HMI
Indicated Value							

Comments see log sheet no.
*CT & PT Ratio as per approved drawing

Power Measurement													
Injected Value	Phase Angle	Active Power				Reactive Power				Power Factor			
	V with ref. to I	Calculated Value	BCU	HMI	Err. (%)	Expected Value	BCU	HMI	Err. (%)	Calculated Value	BCU	HMI	Err. (%)
I = U =	0°									1			
	60°									0.5			
	90°									0			
	120°									-0.5			
	-120°									0.5			
	-60°									-0.5			

Transformer Measurement Values				
Injected	Measured			Checked
Simulator	HMI	Error (%)	Remote Control Center	
Oil Temperature °C				☐
Winding Temperature HV °C				☐
Winding Temperature IV °C				☐
Winding Temperature LV °C				☐
Oil Temperature °C				☐
Winding Temperature HV °C				☐
Winding Temperature IV °C				☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Winding Temperature LV °C				☐
..... °C				☐

General Station Analogue Values					
Injected	HMI	Measured SUPERVISORY		Checked	Comments see log sheet no.
Simulator	Display	Error (%)	Transmitted		
Outside Temp(°C)				☐	
Outside Humidity %				☐	
SCADA Room Temp (°C)				☐	
Telecom Room Temp(°C)				☐	
Battery Room Temp(°C)				☐	
SPR… Temp(°C)				☐	
SPR… Temp(°C)				☐	

Aux system Analogues Values						
Injected		HMI	Measured SUPERVISORY			Comments see log sheet no.
Simulator		Display	Error (%)	Transmitted	Checked	
Current 220V DC 1 O/P	....A				☐	
Voltage 220V DC 1 O/P	... V				☐	
Current 220V DC 2 O/P	....A				☐	
Voltage 220V DC 2 O/P	... V				☐	
Current 48V DC 1 O/P	....A				☐	
Voltage 48V DC 1 O/P	... V				☐	
Current 48V DC 2 O/P	....A				☐	
Voltage 48V DC 2 O/P	... V				☐	
MSB Incomer-1 Votlage	... V				☐	
MSB Incomer-2 Votlage	... V				☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Aux system Analogues Values						
Injected		HMI	Measured SUPERVISORY			Comments see log sheet no.
Simulator		Display	Error (%)	Transmitted	Checked	
MSB Bus-1 Votlage	... V				☐	
MSB Bus-2 Votlage	... V				☐	
LVAC Incomer-1 Votlage	... V				☐	
LVAC Incomer-2 Votlage	... V				☐	
LVAC Bus-1 Votlage	... V				☐	
LVAC Bus-2 Votlage	... V				☐	
MSB Incomer-1 Current	....A				☐	
MSB Incomer-2 Current	....A				☐	
LVAC Incomer-1 Current	....A				☐	
LVAC Incomer-2 Current	... V				☐	
LVAC Bus-1 Votlage	... V				☐	
LVAC Bus-2 Votlage	... V				☐	
Diesel Generator Voltage	... V				☐	
Diesel Generator Current	..A				☐	
----------					☐	
Other Aux system measurements if any					☐	

5.16. CHANGING OF ALARM LIMITS

For supervising the analogue values each measured value shall have high and low alarm limits available. It shall be possible to set each limit independently at the BCU stage. When an alarm limit is detected as having been transgressed an alarm shall be generated and the value displayed on the VDU shall be identified as in alarm status by use of color or other means to the approval of engineer.

	Set point	Checked	Comments see log sheet no.
Voltage	- upper limit: 107% of nominal value	☐	
	- lower limit: 95% of nominal value	☐	
	- processing of alarm limits (color)	☐	
	- hysteresis	☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

	- alarm dead band	☐	
Current	- 1st upper limit: 1000A for 400&765kV level	☐	
	- 2nd upper limit: 1500A for 400&765kV Level	☐	
	- processing of alarm limits (color)	☐	
	- hysteresis	☐	
Frequency	- upper limit: 105% of nominal value	☐	
	- lower limit: 95% of nominal value	☐	
	- processing of alarm limits (color)	☐	
	- hysteresis	☐	

5.17. REDUNDANCY AND DIAGNOSTIC FUNCTION

The SAS system is designed for a hot/hot configuration. To fulfil this functionality following test will be performed:

5.17.1. SAS – SERVER REDUNDANCY

Purpose

In case of server failure the connected HMI operator workstations must switch to the healthy server.

Setup

Ensure setup as per approved SAS Architecture Drawing.

Procedure

1. With both Servers operational, verify that Clients are connected with their respective servers &can perform normal functions i.e. open different screens, alarm & trend screen.
2. On OWS-1 (Server1), Close the Server1 Application.
3. Check that the Alarm appears on the client.
4. Observe that Client1 is now connected with the Server2.
5. Start the Server1 application on OWS1, observe that Client1 is now connected with the OWS1 after some defined period of interval.
6. On OWS-2 (Server2), Close the Server2 Application.
7. Observe that Client2 are now connected with the Server1.
8. Check that Alarm appear on the client.
9. Start the Server2 application on OWS2, Observe that Client2 are now connected with the OWS2after some defined period of interval.

Shutdown & Startup of Servers

Purpose

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

To verify that the HMI Redundancy is operational during the shutdown of the active server.

Setup

Ensure setup as per approved SAS Architecture Drawing.

Procedure

1. With both Servers operational, verify that OWS-1 relate to Server-1.
2. Shutdown Server-1. Observe that OWS-1 is now connected with the Server-2 and receives communications from the remote devices.
3. Startup Server-1 . Observe that there is no interruption to the Bay Level Devices. Restart the Client.
4. Observe that Client is now connected with the Server-1 (Primary Server) and receives communications from the remote devices.
5. Shutdown Server-2. Observe that OWS-2 is still connected with Server-1.
6. Startup Server-2. Observe that there is no interruption to the Bay Level Devices.

Voltage Level substation controller/Servers	Checked	Switch over time	Comments see log sheet no.
Server1 faulty: Disconnect Server1 from LAN and generate new inputs (events and alarms) on BCU. Initiate control of any switching device. • *Check switchover of connected HMIs to Server 2* • *Check updating of information event/alarm/analogue appearance on HMI 1& 2* • *Check execution of command* • *Check appearance of event/alarm* • *Check fault indication of Server 1*	☐ ☐ ☐ ☐ ☐		
Server2 faulty: (Server1 healthy again) Disconnect Server2 from LAN and generate new inputs (events and alarms) on BCU. Initiate control of any switching device. • *Check switchover of connected HMIs to Server 1* • *Check updating of information event/alarm/analogue appearance on HMI 1 &2* • *Check execution of command* • *Check appearance of event/alarm* • *Check fault indication of Server 2*	☐ ☐ ☐ ☐ ☐		

5.17.2. HMI OPERATOR WORKSTATION REDUNDANCY

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Each HMI operator workstation is independent of the other operator workstation and in case of failure the second workstation remains operational

	Checked	Comments see log sheet no.
HMI 1 faulty Disconnect HMI1 from LAN and generate newinputs (events and alarms) on BCU. Initiate control of any switching device. • *Check updating of information on HMI 2* • *Check execution of command* • *Check appearance on dot printer* • *Check fault indication of HMI 1*	☐ ☐ ☐ ☐	
HMI 2 faulty (HMI 1 healthy again) Disconnect HMI2 from LAN and generate newinputs (events and alarms) on BCU. Initiate control of any switching device. • *Check updating of information on HMI 1* • *Check execution of command* • *Check appearance on dot printer* • *Check fault indication of HMI 2*	☐ ☐ ☐ ☐	
HMI 1 and HMI 2 healthy again Check database synchronizing	☐	

5.17.3. ETHERNET SWITCH CONFIGURATION

Purpose

To verify that

- Proper configuration of Ethernet switches at the Station & Process level.
- To enable proper ring formation of the Ethernet switch in station & Process level
- To Document the Ethernet switch configuration considering the proper function of Ring network.

Typical Procedure:

- All IEDs & TCP/IP devices which are connected to non-RSTP ports, such ports should be configured as Edge port.
- Edge port should not be enabled with RSTP or Auto to reduce the ethernet switch processing.
- Only Point to Point port should be enabled with RSTP.
- Other than Edge port, all other unused ports should be disabled.
- Point to Point port & Discarding port need to be properly connected as per the System architecture.
- Ensure Bridging priority, Edge port, RSTP, VLAN configuration in Root & Non-Root Ethernet switches should be as per project requirement & Documented as below given example.

Sr. No	Panel Location	Switch Identification	Switch Port No	Bridge Priority	Edge Port	Switch to Switch Port	Un-used Port	RSTP	VLAN
1.	+R404A	K404	1	8192	No	Yes	No	Yes	As per Network requirement
2.	+R404A	K404	2	8192	No	Yes	No	Yes	As per Network requirement
3.	+R404A	K404	3	8192	No	Yes	No	Yes	As per Network requirement
4.	+R404A	K404	4	8192	No	Yes	No	Yes	As per Network requirement
5.	+R404A	K404	5	8192	Yes	No	No	No	As per GCB Table
6.	+R404A	K404	6	8192	Yes	No	No	No	As per GCB Table
7.	+R404A	K404	7	8192	Yes	No	No	No	As per GCB Table
8.	+R404A	K404	8	8192	Yes	No	No	No	As per GCB Table
9.	+R404A	K404	9	8192	Yes	No	No	No	As per GCB Table
10.	+R404A	K404	10	8192	Yes	No	No	No	As per GCB Table
11.	+R404A	K404	11	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
12.	+R404A	K404	12	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
13.	+R404A	K404	13	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
14.	+R404A	K404	14	8192	Auto	Auto	Disabled	Yes	Default/Not applicable

Note: Control Room Switches has to be Kept as Root Bridge Switch and rest of the switch has to be followed the RSTP Philosophy. SAS Architecture has to be updated with these number if possible for better clarity.

	Checked	**Comments see log sheet no.**
Document Switch port configuration -IP address of the switch, Bridge numbering, VLAN, IP address, Edge port of as per project requirement considering GCB & considering Ring system	☐	

POWERGRID Representative	**Manufacturer Representative**
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

5.17.4. NETWORK REDUNDANCY

The reliability and security of the redundant LAN configuration will be checked.

Purpose

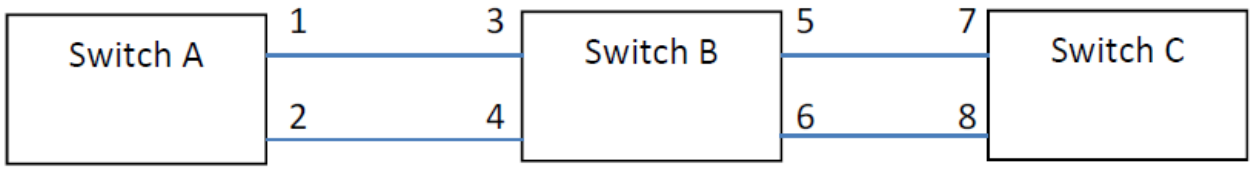
To verify that

- Ethernet connections in the Substation Automation System are functional and running.
- LAN Switch Redundancy is functional.

To establish that in the event of a loss in communications, the SAS device is OFFLINE. When the communications link is restored, the SAS device is automatically back to ON-LINE.

ETHERNET LAN REDUNDANCY CHECK

1. Choose a Switch in the LAN. Let it be Switch B in below fig having switches A & B adjacent to it. There are two ports, 3 & 4 of switch B connected to two ports, 1 & 2 of switch A. Similarly there are 2 other ports in switch B, 5 & 6 connected to ports 7 & 8 of switch C (as shown in figure).



2. On switch B Disconnect port 3 LAN cable. Verify that no device in the entire system fails to communicate.
3. On switch B Disconnect port 4 LAN cable. Verify that no device in the entire system fails to communicate.
4. On switch B Disconnect port 5 LAN cable. Verify that no device in the entire system fails to communicate.
5. On switch B Disconnect port 6 LAN cable. Verify that only those devices, which are connected to switch B, fail to communicate.
6. Restore the LAN cables in reverse order and check that communication of the devices above gets restored.
7. Repeat the above for all other switches in the Redundant RING LAN.

LAN Communication Functional Check test Results Log

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

S.NO.	Panel	Equipment	Communication check	Redundancy check
1	_____KV BCU (Bay 01/02/03---)			
2	_____KV BCU (Bay 01/02/03---)			
3	Networking Panel			

	Checked	Comments see log sheet no.
Checking Station Ethernet ring Checking functionality in case of disconnecting and connecting the ring at several points. Initiate control of any switching device. • *Check redundancy.* • *Check fault indication from adjacent units.* • *Check appearance on HMI 1 & 2* • *Check execution of command* • *Check dynamic animation of SCADA pictures (Communication ports status etc.)*	☐ ☐ ☐ ☐ ☐	
Checking Bay Ethernet ring Checking functionality in case of disconnecting and connecting the ring at several points. Initiate control of any switching device. • *Check redundancy.* • *Check fault indication from adjacent units* • *Check appearance on HMI 1 & 2* • *Check execution of command* • *Check dynamic animation of SCADA pictures (communication ports status etc.)*	☐ ☐ ☐ ☐ ☐	
Checking the communication of switches Checking functionality in case of disconnecting and connecting the Ethernet switches and router at several points. Initiate control of any switching device. (1x optical, 1x electrical, 1x 1GB port) • *Check redundancy* • *Check fault indication from adjacent units* • *Check appearance on HMI 1 & 2* • *Check execution of command* • *Check dynamic animation of SCADA pictures (communication ports status etc.)*	☐ ☐ ☐ ☐ ☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

5.17.5. GATEWAY REDUNDANCY (IEC 101 & IEC104 PORTS)

The redundancy of the IEC 101/104 communication interface from the Gateways will be checked. As the real SCADA system is not available, two no of Laptops with the IEC TEST – Softwares are used to simulate the RCC& RSCC.

5.17.6. TIME SYNCHRONIZATION REDUNDANCY

Redundancy of GPS time synchronization is tested. One clock will be disconnected from the network. It is checked that the various devices are still time synchronized (i.e. by changing the time manually for a device and checking that it gets synchronized again).

Time synchronization redundancy	Checked	Comments see log sheet no.
Disconnect GPS time server 1 from the network Check availability of correct time synchronization Reconnect GPS time server 1 and disconnect time server 2 (any one of the IED/OWS internal clock) from the network Check availability of correct time synchronization	☐	

5.17.7. SAFETY TAG FACILITY

It is checked that safety tag facility is realized in SCADA. A triangle with exclamation mark is set on the respective switching device.

	Checked	Comments see log sheet no.
Processing of safety tag facility	☐	
Properties of safety tagging - 3 different types of safety tags - notebook facility (date, time, user, ...) - prevent of SCADA control	☐	
Display on the - overview picture - individual bay display	☐	
Check appearance on redundant server/operator	☐	

5.17.8. MAINTENANCE MODE

It is checked that individual feeders can be set into maintenance mode. No control is possible, and no alarms/events can come up during the feeder is in maintenance mode, which is indicated by annunciation “MAINTENANCE MODE.”

	Checked	Comments see log sheet no.
Feeder is in “Maintenance Mode”	☐	

	Checked	Comments see log sheet no.
Check appearance on HMI Display	☐	
Check control blocking	☐	
Check suppression of data transmission	☐	

5.17.9. IMPORT AND EXPORT OF ARCHIVED PROCESS DATA

The backup/ archiving function will be checked under this chapter. Data, which was outsourced as backup files will be imported into the runtime and displayed in the event list in conjunction with the filter function. During import mode no changes of any other archive type or date are possible. The “Archive” button starts blinking when an import succeeded. Afterwards the imported messages can be saved into a readable format (as *.csv or *.txt). The export button function will remove the backup database from the event list and the “Archive” button stops blinking.

	Checked	Comments see log sheet no.
Import from archive	☐	
Export data to readable format to Excel (*.csv or *.txt)	☐	
Export to archive	☐	

5.18. ADDITIONAL TESTS

In this chapter the remote access to bay control unit and protection relays will be checked. In addition, some protection tests will be simulated for checking information recording in SAS-system.

	Checked	Comments see log sheet no.
Remote access to IED devices via DR PC: - Password security - Access/Load function with ability to change relay settings. - Download of fault records - Automatic download of DR (Built-in & Stand-alone) fault record with necessary S/w - Evaluation of Fault records with evaluation S/w - Connection to 3rd party relays	☐ ☐ ☐ ☐ ☐ ☐	
Remote access to BCUs and via DR PC: - Password security - Access/Load function with ability to change relay settings	☐ ☐	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Information recording in SAS-system - Reset of trip lockout relay - Autoreclosing ON/OFF selection - Reporting of fault location	☐ ☐	
- Hardcopy print (to paper and file)	☐	

5.19. REMOTE DESKTOP

The remote desktop function is a feature of Windows. It is shown as an icon on the desktop of all PCsof this station. Pressing this button and a window will appear. Choose the desired PC by selecting its IP address; the remote desktop function opens the desktop of the desired PC. It is mainly used for configuring the station controllers and HMI servers from the Engineering PC.

Remote desktop	Checked	Comments see log sheet no.
Remote desktop functionality by using both IP & Their PC name	☐	

5.20. TIME SYNCHRONIZATION

The time synchronization is checked under this chapter. The antenna of the GPS clock is disconnected. An alarm should be generated. Then the times of the devices is changed by hand for a few minutes only. Connect the antenna again. The devices have to synchronize again by themselves after some minutes and the alarm must disappear. The time synchronization test shall be performed by making GPS as the master clock for synchronizing all IED's present on ring network.

Procedure

1. Disconnect the GPS Receiver Antenna. Set the GPS Receiver to send Local Time.
2. Confirm that the External Time Display Unit displays this local time.
3. Confirm that IEDs Operator Workstations and Substation Gateway Times match this local time. This confirms that the SNTP packets are broadcast by the GPS receiver.
4. Confirm that GPS Receiver unsynchronized alarm is received in the workstations.
5. Power off the GPS receiver.
6. Verify that all IEDs are synchronized with any of the IED/OWS designated as redundant Timeserver.
7. Power on the GPS receiver.
8. Connect the GPS receiver Antenna. Verify that the GPS receiver is locked with satellite and GPSis updated to satellite time.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

9. Confirm that the External Time Display Unit, The IEDs, Operator workstations and the Substation Gateway are updated to the correct time of GPS.

Time synchronization	Checked	Comments see log sheet no.
OWS-1 & Server-1	☐	
OWS-2 & Server-2	☐	
DR PC	☐	
Auxiliary System	☐	
Reporting of Time synchronization alarm of connected all IEDs in the network	☐	
Bay Control Unit	☐	
Event list printer/ Hardcopy/ Logbook printer	☐	

5.21. VALIDATION OF MEMORY AND DISK UTILIZATION

Purpose

To verify that the OWS/HMI have Memory and Disk Usage and allocation those are within the specification requirements. 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 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 for two years and trend data for thirty(30) days,
2. Storage of all necessary software,
3. 500GB space for OWNER'S use.

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

Setup

Ensure that the Servers are running and functioning properly.

Validation of OWS Memory and Disk Utilization

Computer	Physical Memory	Hard Drive Free Space	PASS/FAIL
SERVER-1			PASS/FAIL
SERVER-2			PASS/FAIL
OWS-1			PASS/FAIL

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Computer	Physical Memory	Hard Drive Free Space	PASS/FAIL
OWS-2			PASS/FAIL
DR/EWS PC			PASS/FAIL
GATEWAY-1			PASS/FAIL
GATEWAY-2			PASS/FAIL

5.22. BCU INPUT/OUTPUT/ANALOG DATA RETRIEVAL

Configuration of data reporting at defined interval/cyclic and dead band shall be verified as per approved profile to evade hanging of both SCADA and IED.

The following are the procedures in the BCU I/O Data retrieval. The individual BCU Test result logs are to be filled up in the following sections.

Digital Input Retrieval

Purpose

To verify that the change of state of Digital Input points are updated in the BCU LHMI, the Operator Workstations and Master Station Simulator.
To verify that the Digital Inputs are mapped correctly as per the approved drawing.

Setup/Program

1. Connect the test jig to the BCU under test.
2. Go to the BCU LHMI Digital Inputs Display screen.
3. On the OWS-1 go to the relevant HMI screen.
4. On the OWS-2 go to Alarm/Event list.

Procedure

1. Select a Digital Input point on the BCU under test.
2. Change its state from ‘OFF’ to ‘ON’ (single points) or from ‘OPEN’ to ‘CLOSED’ (double points) bytoggling the corresponding jig.
3. Verify that the state of this point in the BCU LHMI and HMI is changed correctly.
4. Verify that the state of this point in the OWS-2 event list screen is changed correctly.
5. For points configured with alarm, verify that alarms are displayed in the Alarm Screen of the OWS-2 with correct time stamp.
6. For points considered in the IEC 60870-101/104 List, verify that the state of this point in the Master Station Simulator is changed correctly with correct time stamp.
7. Change its state from ‘ON’ to ‘OFF’ (single points) or from ‘CLOSED’ to ‘OPEN’ (double points) bytoggling the corresponding jig.
8. Repeats step 3 to 6

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

9. Repeat 1 to 8 for all Digital Input points to be tested on this BCU.
10. Repeat steps 1 to 9 for all BCU's.
11. Data reporting shall be verified to evade hanging of both SCADA and IED. Necessary simulation (including analog) shall be done by vendor.

Digital Output

Purpose

To verify that digital output operations are successfully executed.
To verify that the Digital Output points are mapped correctly according to the approved drawings & Data List.

Setup/Program

1. Connect the test jig to the BCU under test.
2. Go to the BCU MMI Digital Outputs Display screen.
3. On the OWS-1 go to the relevant HMI screen.
4. On the OWS-2 go to Alarm/Event list.

Procedure

1. Choose BCU to test. From the HMI workstation initiate digital output requests.
2. Verify that the corresponding output activated.

Software Interlock Logic

Purpose

To verify that software interlock logic for CBs and Isolators are operational based on simulated conditions.
Note: Since not all interlock conditions can be tested during FAT, other interlock inputs shall be simulated by shorting auxiliary contacts at the terminal blocks of the panels.

Setup

1. Set up the test jig to simulate software interlock positive and negative test conditions.
2. Set up shorting links to simulate other auxiliary contacts.
3. Refer approved drawings.

Procedure

1. Select a BCU to test.
2. Refer to the interlock conditions for testing. First set up a negative condition. Attempt to operate controls related to the interlock logic being tested. Verify that the interlock is successful.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

3. Set up for a positive test condition. Verify that interlock is successful when control operation is performed on related to the interlock logic being tested.

CB/ Isolators	CB/Isolators Interlock Negative Test Result	CB/Isolators Interlock Positive Test Result	CB/Isolator Condition	Checked

Note: Interlock involving GOOSE signal shall also be checked. It shall be ensured that absence of required GOOSE signal does not enable any interlocking condition. Interlock verification page for each control device as per TS based on the available input in the BCU to be prepared in HMI. Spare switching arrangement for Single phase reactor and transformer banks shall be verified by simulation and software interlocks to be verified.

5.23. SUBSTATION CONTROLLER DEVICE REPORTING

Purpose

To verify that the Substation Controller (Server/Client) is successfully communicating with the bay level devices using IEC 61850 protocol.

Setup

1. Ensure that the Server/Clients are running.
2. Go to the System Architecture Screen on Client.

Procedure

1. On the System Architecture screen, verify that the bay device status is Normal.
2. Go to a remote device and disconnect the LAN cable, verify that the System Architecture screen shows the bay device is Failed.
3. Connect the LAN cable. Monitor the communication between Server and remote device and verify that the IEC 61850 packets between the two TCP/IP addresses are passing through.
4. Verify that the System Architecture Screen shows that the device is Normal.

Repeat the above procedures for other devices.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

6. EWS/DR PC

6.1. SETTING AND CONFIGURING OF IEDS

Purpose

To verify that the IEDs configuration with proper tool for each type has been installed and all the IEDs (Protection, BCU, RTCC, CSD, FOTS & other TCP/IP devices) are accessible via the station ethernet ring. The DR PC should be able to change any configuration, settings, IP address & other parameters via TCP/IP should be possible.

Setup

1. Ensure that DR PC is running.

Procedure

(For example, for BCU)

1. Change some parameters in S/W for the BCU to test. Compile the Database for which parameters have been changed. (Wherever applicable)
2. Run S/W on the DR PC and select the compiled Database. Connect the BCU for which the parameters have been changed. (Wherever applicable)
3. Upload the database. (Wherever applicable)
4. Verify that the download is successful and check the DB version on the BCU. (Wherever applicable)

(For example, for Protection IED)

1. Change some parameters in S/W for the Protection IED to test. Compile configuration for which parameters have been changed. (Wherever applicable)
2. Connect the IED for which the parameters have been changed. (Wherever applicable)
3. Download the configuration or setting changed to the respective device. (Wherever applicable)
4. Verify that the download is successful and check the version on the IED. (Wherever applicable)

6.2. NETWORK MONITORING SYSTEM

Purpose

To verify that the Network Monitoring System (NMS) application software can perform the following functions on the LAN devices for both station bus & process bus:

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

- Configuration Management
- Fault Management
- Performance Monitoring
- Device Monitoring
- Log analysis
- Historical Data storage

Note:

1. **The Network Management System is based on Simple Network Monitoring Protocol (SNMP). Some background on this protocol is needed to understand how the application software works. If a separate network is available, then the each network has to have NMS separately example like Sample Values network in Process bus substation.**
2. **SNMP V3 may be implemented for the new projects. For extension projects, the existing SNMP version may be used.**

Procedure

1. Verify that NMS software monitors LAN devices statistics and present these using displays.
2. Verify that it maintains connectivity and device status, issues alarms on errors conditions. This can be verified in the Operator interface(OI) client screens.
3. Verify that it has tools for maintenance of addressed and links.

6.3. AUTO RECLOSE TEST

6.3.1.TEST FOR AUTO-RECLOSE SUCCESSFUL CASE

1. Select the Circuit Breakers of Main & Tie on which Auto reclose must be tested.
2. Ensure that the Circuit Breakers are in closed condition and Auto-recloser is in ON state and all interlock conditions for closing the breaker are satisfied.
3. Simulate 1-Phase trip, ensure that the corresponding phase of the Main & tie breakers open.
4. Ensure that the Main Circuit Breaker Auto recloses first with predefined dead time (1sec) and Tie- breaker auto recloses once the main breaker reclose cycle is completed as per the priority logic.
5. Ensure that once Auto-recloser is successful for main, the respective reclaim timer starts and Auto-reclose State goes back to Normal once the reclaim time is over and the same is applicable for TIE bay.
6. Put Auto-recloser of main CB in off position. Repeat steps 1 to 3. In this case ensure that Main CB does not go for Auto-reclose and tie CB Auto-reclosers without priority (1 sec)
7. Check that Auto-reclose does not take place for CB which are already in open condition. Check this for both main & tie CB.
8. Check that A/R does not take place for CB having A/R lockout condition (SF6 gas pressure/Oilpressure/spring discharge). The healthy CB associated with the feeder shall A/R successfully.
9. Repeat steps 4-6 for 3 phase auto reclose and single phase/3 ph. Auto reclose

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

10. In case of single-phase fault for 3ph. Autoreclose selection, the single phase trip shall be connected to 3 ph. trip before autoreclose.

6.3.2.TEST FOR AUTO-RECLOSE FAILURE CASE

1. Repeat steps 1to 5 of successful case, Once the reclaim time starts, simulate another 1-Phase trip.
2. Ensure that the Auto-reclose enters Locking State and a 3-Ph tripping is issued to the both Main and Tie Breaker and all the 3-phases of the breaker open.
3. Repeat steps 1to 3 of successful case, Once the Auto-recloser cycle starts, before the dead time is over and close command is issued to the Main and Tie Breaker, Simulate another 1-ph trip. In this case also Auto-recloser enters Locking State and a 3-Ph tripping is issued to the both Main and Tie Breaker and all the 3-phases of the breaker open.
4. Repeat steps 1to 3 of successful case, Once the Auto-recloser cycle starts, before the dead time is over and close command is issued to the breaker, simulate the AR blocking signal, ensure that the Auto-reclose does not take place and Auto-recloser goes back to its Initial state.

7. DR CONFIGURATION

Check DR is configured as per TS & Latest standardized DR signal list configuration.

i. Analog triggering level
ii. Signal name and order
iii. Pre-& Post fault time (Pre-fault time: min 500ms)
iv. Triggering Channel
v. Re-trigger option etc.

7.1. AUTO DR FUNCTIONALITY

Purpose

To verify that the automatic disturbance file is uploaded to DR PC when the disturbance is created.

Setup

1. Ensure that DR PC is running.
2. System Software should be running on the DR PC.

Procedure

1. Create the Disturbance on Main-1 &2, Verify that the disturbance has been created in the relay.
2. Ensure the Folders must be created for all Main-1&2, BCU folders based on the substation structure.
3. Observe that the Disturbance File (.cfg/.dat etc.) is automatically created in the DR PC.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

4. Open the Disturbance file with DR software.
5. As per the NTAMC AFAS requirement all the details of the IEDs has to be provided along with the location of the Folder created for each Protection IED
6. Verification of auto DR downloading functionality on triggering of waveform in each IED.
7.

8. IEC 60870-5-101/104 DATA RETRIEVAL

Purpose

To perform preliminary verification that the IEC 60870-5-101/104 Communication Ports are functional.

Setup/Program

- Ensure that the test equipment is in the FAT room.
- Use a Protocol Analyzer Test set to simulate an IEC 60870-5-101/104 Master Station polling with General Interrogation and data changes with 2 no of laptop. Use the Protocol Analyzer Test set to Monitor IEC 60870- 5-101/104 Telegram on the redundant serial communications links.

Procedure

1. Verify that communication is established with the simulator Protocol Analyzer Test set.
2. Verify that the simulator is sending requests on the primary channel and that the SAS Gateways is responding on both the primary (Main) and the secondary (Standby) channels.
3. Disconnect the simulator from the primary channel and connect it to the secondary channel; verify that the SAS Gateway will respond on both channels to requests received on the secondary channel.
4. Verify that data present at HMI should be same at Protocol Analyzer Test also.
5. Verify that all the configured required data points are sent by the gateway to the simulator.
6. Configuration of data reporting at defined interval/cyclic (generally analog without time tag), dead band shall be verified as per approved profile.

8.1. MASTER DIGITAL INPUTS RETRIEVAL

Purpose

To verify that the Substation Gateway is polled for Digital Input data correctly by the Master Simulator.

Procedure

1. Inject digital input changes to single point and double point inputs.
2. Verify change of the state in the Gateway Machine and Protocol Analyzer.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

8.2. MASTER ANALOG INPUTS RETRIEVAL

Purpose

To verify that substation gateway is polled for Analog Input data correctly by the Master Simulator.

Procedure

Inject Analog Inputs and verify that the Analog data are correctly received by the Master Simulator.

9. STATEMENT OF SYSTEM ACCEPTANCE

Upon satisfactory completion of all applicable tests specified in this document and the proper disposition of all properly documented and witnessed discrepancies resulting from tests specified in the procedure, the system, tested and witnessed by the POWERGRID is functionally accepted by POWERGRID.

The following documents has to be submitted for the clearance of the SAS wherever applicable.

Final FAT submission Verification log:

Sl No.	Description	Drg No.	Checked
1	Standard Approved MQP		☐
2	Approved FAT Procedure		☐
3	GTP-General Technical Parameters		☐
4	Complete SAS Architecture		☐
5	Standard General Technical Particulars for SAS		☐
6	Hardware specification		☐
7	Functional Design Specification		☐
8	VLAN Architecture drawing wherever applicable		☐
9	Matrix for GOOSE messages for each feeder (with publisher& subscriber details, Mac id, APP Id, VLAN as required)		☐
10	Matrix for SV (with publisher & subscriber details, SV ID, Destination mac and VLAN details) in case of Process Bus substation		☐
11	Ethernet Network Configuration Document (RSTP details, VLAN details, Port details etc.)		☐
12	IP Addressing Details		☐
13	Single SCD File of the Entire substation		☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Sl No.	Description	Drg No.	Checked
14	Exported HMI signal list file in spreadsheet/CSV format.		☐
15	Exported NTAMC signal list file in spreadsheet/CSV format.		☐
16	Common BCU/Alarm Panel-01		☐
17	Common BCU/Alarm Panel-02		☐
18	GA & Scheme of Networking Panel		☐
19	CRP (Line/Trafo/BR/LR/Tie/BC/TBC/BS/Etc)		☐
20	Product Manuals(Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)		☐
21	Control Room Lay-out		☐
22	Switchyard Panel Room layout drawing		☐
23	Bill of Quantity-Spares		☐
24	**Other applicable drgs (not listed above)**	**Attach the list as annexure**	☐

Note: A single SCD file shall be there for the entire substation. For extension projects too, the SCD file shall be a single file after integrating the newer IEDs.

Softcopy of Manuals Log:

Document Title	Doc. No.	Checked
Operation and Technical Guide for BCU, Gateway, Server, OWS Software		☐
Operation and Technical Guide IED configuration softwares		☐
Operation and Technical Guide NMS Software		☐
Operation and Technical Guide Ethernet Switch		☐
Operation and Technical Guide Time synchronizing Equipment		☐
Operation and Technical Guide Router Cum Firewall		☐
Operation and Technical Guide UPS/Inverter		☐
Other applicable equipment Operational & Technical Guide		☐

Softwares/Project Backups/License details Backup:

Software/License	Doc. No.	Checked
Protection Project Configuration- As Manufactured		☐
HMI Project Database – As Manufactured		☐

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Software/License	Doc. No.	Checked
Gateway Project Database – As Manufactured		☐
Ethernet Configuration – As Manufactured		☐
Any other Configuration(NMS, Syslog, etc)- As Manufactured		☐
HMI associated Software & their license		☐
Gateway associated software & their License		☐
MS office & license		☐
NMS & their license		☐
Protection & Control each type Software & license		☐
CSD, FOTS, RTCC & Other Devices Software & license		☐
Antivirus software & license		☐
Printers software & license		☐
GPS clock software & license		☐
Other applicable equipment Operational & Technical Guide		☐

10. DURATION OF FACTORY ACCEPTANCE TEST

The duration of the Factory Acceptance Testing will be mutually agreed depending upon the size of the substation.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

11. INDICATION AND CORRECTION REPORT

Any comments should be added in “log sheets”; Along with the Clerance the Indication and Correction report with compliance has to be submitted to the respective Site/RHQ/CC AM.

INDICATION AND CORRECTION REPORT

LOG SHEET:

No.	Reference	Author	Date

Description

POWERGRID Representative	**Manufacturer Representative**
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

12. APPENDIX

GLOSSARY

BCU: Bay Control Unit
DR: Disturbance Recorder
EWS: Engineering Workstation
FAT: Factory Acceptance Test
FPT: Functional Performance Test
FST: Factory Simulation Test
GTW: Gateway
GPS: Global Positioning System
IED: Intelligent Electronic Device
NMS: Network Management (Monitoring) System
OWS: Operator Workstation
RCC: Remote Control Centre
RSCC: Regional System Co-ordination Centre
SAS: Sub-station Automation System
SAT: Site Acceptance Test
SCADA: Supervisory Control And Data Acquisition

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

Appendix-III

Factory Acceptance Test (FAT) Procedures & Formats

-Control Protection System

Power Grid Corporation of India Ltd.
Saudamini, Plot no.2, Sector-29, Gurgaon, Haryana 122 001

DOC: PG/CC/CRP/FAT, Rev01				
Revision	**Department**	**Date**	**Signature**	**Signature**
01	CC/Engg CC/QAI CC/AM	09.11.2023	Sd/	Sd/

REVISION HISTORY

Sl.No.	Pages	Revision	Remarks
01	All Pages	01	First Release

CONTENTS

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

About This Document

Purpose of this document

This document shall be used as a standard for conducting all tests during the Factory Acceptance Test (FAT) for the Control & Protection system of every substation as per POWERGRID requirements and specifications.

The aim of the Factory Acceptance Test (FAT) is to demonstrate equipment functionalities as well as the approval process of the system-parameterization by POWERGRID to reduce the change requests during commissioning at site. 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.

During FAT the entire Sub-station Control and Protection system to be supplied shall be tested for complete functionality and configuration in the factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure defect free installation at site. No major change in configuration/setting of system is envisaged at site.

This document details the equipment and functions under test and the corresponding test methods as well as the test documentation.

Who should use this document

This document to be used by the Vendor representatives (Q&I, Engg, Factory) for Factory acceptance test as per the project requirement. This approved document will be followed by the Vendor Representatives (Q&I, Engg, Testing) and POWERGRID representatives to test and evaluate the complete system.

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

1. GENERAL

1.1. Introduction

The purpose of this document is to define the Factory Acceptance Test procedures of Substation Control & Protection system supplied by the Vendor to POWERGRID.

The tests are performed by Vendor and each test, or set of tests as appropriate, is covered by an approval stage, which will be signed off upon completion by Vendor and POWERGRID representatives.

Comments are noted in separate Incident and correction reports (snag list) attached as annexure.

2. CONTROL & PROTECTION SYSTEM

2.1. FAT test methodology

FAT testing will be performed for Control & relay panels for ensuring the manufacturing as per the approved CAT-I drawings. Pre-FAT test sheets will be used as a reference for the tests to be performed during the FAT.

These test sheets will indicate the specific units that were tested during pre-FAT tests.

2.2. List of Control & Protection Panels

Feeder / Panel	Feeder Specification	Description	Drawing CSD No.	Rev. No.
401	400kV Meerut-Moradabad Line-1	LINE	CPD KZ5J SC43	CAT-I
402	TIE	TIE	CPD KZ5J SC44	CAT-I
403	ICT-500MVA-1	ICT	CPD KZ5J SC45	CAT-I
BB	Busbar Protection panel	BB	CPD KZ5J SC55	CAT-I
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POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

2.3. Test report overview

FAT Test	Description	Line	Auto/Power Transf.	Bus/Line Reactor	Busbar	Tie	BC/TBC
FAT001	Visual Inspection	X	X	X	X	X	X
FAT002	Hardware Verification	X	X	X	X	X	X
FAT003	AC Scheme Check	X	X	X	X	X	X
FAT004	DC Scheme Check	X	X	X	X	X	X
FAT005	Auxiliary Report	X	X	X	X	X	X

POWERGRID Representative	**Manufacturer Representative**
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

2.4. Document verification

2.4.1. Document verification test

Purpose:

This test verifies that the correct manufacturing drawings and documentation for the equipment/system under the test will be used during the Factory Acceptance Test.

Procedure:

1. Verify that approved drawings (printed and soft copies) of all assembled equipment are present.
2. Verify all required hardware and software manuals are present.
3. Guaranteed Technical Parameters (GTPs) as approved by POWERGRID.
4. A copy of Customer Technical Specification for reference is made available in the FAT room.
5. Availability of the approved Drawing list in the FAT room.

Document Verification Log:

Sl No.	Description	Drg No.	Checked
1	Approved Standard MQP		☐
2	Standard FAT Procedure		☐
3	Approved GTP-Guaranteed Technical Particulars		☐
4	Approved Hardware specification & BOM		
5	Latest Approved Protection Logic diagram (Line/Transformer/Reactor/BB/etc) (Refer POWERGRID Intranet) *		☐
6	Latest Approved settings/configuration template (pdf) (Refer POWERGRID Intranet)		☐
7	Approved GA & Schematic CRP Drawings (Line/Transformer/Reactor/BB/etc)		☐
8	Product Manuals (Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)		☐
9	Approved Bill of Quantity spares		☐
10	Operation and Technical Guide of IED configuration softwares.		☐
11	Operation and Technical Guide of Ethernet Switch		
12	**Other applicable drawings (not listed above)**	**Attach the list as annexure**	☐

Note:- *if there is a variation between the approved protection scheme and the latest approved protection logic diagram uploaded on POWEGRID intranet, later shall prevail.

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

2.5. Pre-acceptance test

2.5.1. Visual inspection

Purpose: This test will be carried out on the panels before commencing any testing on the panels. This test verifies the cleanliness, physical damages, dimensions, color of the panel and its thickness, mounting arrangements and proper ferruling and labeling etc.

Procedure:

1. Record the name and reference number of the panel to be tested in the test sheet.
2. Verify the check list detailed in the test sheet and ensure that the panel under test is in line with the base document.
3. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
4. Repeat step 1 to 3 for the other control & protection panels.

Test Document:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT001: Visual Inspection

Note**:** Copy of this Visual Inspection test sheets will be used for other panels under test

2.5.2. Hardware verification test

Purpose: This test verifies the list, identification data and the quantities of the equipment mounted in each protection panels.

Procedure:

1. Select one of the typical bays.
2. Verify the test sheet selected for the Hardware Verification Test, belongs to the selected typical panel under test.
3. Record the reference number of the selected typical panel to be tested in the test sheet.
4. Verify the list of equipment and its quantities, as specified in the test sheet and it is in line with the base documents.
5. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
6. Repeat step 3 to 5 for the other panels of the same type.
7. Repeat step 1 to 6 for the other control & protection panels.

Test Documents:

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT002: Hardware Verification Test

Note**:** Copy of the respective Hardware Verification test sheets will be used for more than one panel of the same type under test.

2.6. Power scheme verification

2.6.1. AC scheme check

Purpose: This test verifies the AC power circuit of the panel under test. In brief, the test verifies the AC power to the MCBs, heating and lighting circuits and to the power sockets and ensures their operation is correct.

Procedure:

1. Select any of the typical bays.
2. Record the name and reference number of the panel to be tested in the test sheet.
3. Verify the check list detailed in the test sheet and ensure AC circuit is as per the scheme and AC devices are working properly.
4. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.

Test Document:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT003: AC Power Verification

Note**:** Copy of the same test sheets will be used for the other Control & protection panels

2.6.2. DC scheme check

Purpose: This test verifies the DC power circuit of the panel under test. In brief, the test verifies the DC1 and DC2 to the MCBs, DC changeovers and DCs to the various equipment in the panel.

Procedure:

1. Record the name and reference number of the panel to be tested in the test sheet.
2. Verify the check list detailed in the test sheet and ensure the DC circuit of the panel works properly.
3. Perform a DC change over and ensure for no power failures in any equipment
4. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
5. Check complete cubicle wiring as per schematic diagram.

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

6. Repeat step 1 to 6 for the other Control & protection panels.

Test Documents:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT004: DC Scheme Check

Note**:** Copy of the same test sheets will be used other protection panels

2.6.3. Auxiliary relay test

Purpose: This test verifies the functionality and properties of Auxiliary Relay under test.

Procedure:

1. Select a Trip Relay/Lockout Relay from any one of the protection panels
2. Record the panel reference in the test sheet
3. Perform the following routine tests which is applicable for this relay

   - Name plate rating details
   - General inspection
   - Resistance check
   - Secondary injection test
     - Pick-Up / Drop-Off test (operating and resetting coil)

4. Record if any comments in the indication and correction report (snag list) attached as to this document.
5. Repeat step 1 to 5 for the same type of relays for the other panels.

Test Documents:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT005: Routine Test – Auxiliary Relay

Note**:** Copy of FAT005 test sheet will be used for more than one relay of the same type under test

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

2.7. Relay configuration & setting

The configuration of each IED in the system shall be adopted as per the approved scheme by POWERGRID. This configuration must be verified for each feeder (Line, Transformer, Reactor, Busbar & etc) as per the POWERGRID standard setting/configuration template (in pdf format).

The POWERGRID standard setting/configuration template must be referred to finalise the configuration. For any clarifications or corrections on the configurations changes if required the same has to be recorded in the observation & compliance report.

Note:

1. **However, if the approved setting is not available during FAT, standard setting may be used to complete the FAT.**

2. **The Final setting/configuration project file must be submitted as part of the FAT documentation.**

Following important points must be considered during configuration to ensure the proper Configuration & settings.

1. Defined functionality should be available in the configuration as per POWERGRID TS/Standard drawing.
2. Defining the proper input & output variables as per the approved drawings.
3. Tripping & signal assignment as per the approved Trip matrix.
4. Proper Flow of configuration as per the OEM (Ex. Proper instance of function block to avoid any delay or creating loop)
5. Only inbuilt logical functions should be used until otherwise specified.
6. Proper naming of Each section like Binary input, Protection functions, Binary output, LED, DR, SCADA & etc.
7. Naming of the IED should be proper (Ex SS_Name, Feeder Name).
8. Proper SNTP time setting (DST disabled, NTP ip address, SNTP selected).
9. DR channel configuration shall be done as per POWERGRID standard list.
10. Aesthetic alignment of the configuration in a proper readable format.

2.8. Protection relay - FAT

In addition to the standard routine tests as per the manufacturer OEM recommendations, it's important to verify the functioning and operation of Intelligent Electronic Devices (IEDs) according to specified logic required as per POWERGRID during the Factory Acceptance Testing (FAT) period.

For the demonstration of the following tests, the required simulation tools should be available during FAT.

For each feeder, the FAT reports has to be submitted along with the routine test report of the manufacturer.

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Line Feeder (Distance/Auto-reclose/LBB):

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	Carrier aided Permissive Scheme in Main-1 & Main-2.	☐
4	Current Reversal & Weak infeed in Main-1 & Main-2.	☐
5	Fault location for each type of faults.	☐
6	AR logic for the One and half breaker system (Both Main & Tie with priority logic) with Main-1 & Main-2 (For Auto reclose logic refer **"Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System, section- Circuit Breaker Panel", DOC ref: D-2-01-03-01-XX**)	☐
7	AR 3 Ph trip logic as per standard setting template	☐
8	DT circuit checking with all possible condition for 1 ½, DM, DMT busbar scheme.	☐
9	DT & Carrier send/receive logic with Carrier switch out & Carrier fail.	☐
10	Single phase initiation to LBB relay.	☐
11	Simulation of Cross-country fault in Distance function.	☐
12	3Ph trip initiation to LBB relay.	☐
13	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	☐
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	☐
15	Metering function (V, I, P, Q, Hz, PF).	☐
16	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	☐
17	Red Ferruling in the Tripping circuit	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Line Feeder (Differential/Distance/Autoreclose/LBB):

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	Communication failure of Differential enabling the Distance Z-1 function.	☐
4	Carrier aided Permissive Scheme in Main-1 & Main-2.	☐
5	Current Reversal & Weak infeed in Main-1 & Main-2.	☐
6	Fault locator & Mutual compensation Fault location (If applicable).	☐
7	AR logic for the One and half breaker system (Both Main & Tie with priority logic) with Main-1 & Main-2 (For Auto reclose logic refer **"Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System, section- Circuit Breaker Panel", DOC ref: D-2-01-03-01-XX)**	☐
8	AR 3 Ph trip logic as per POWERGRID standard protection logic diagram.	☐
9	DT circuit checking with all possible condition for 1 ½, DM, DMT busbar scheme.	☐
10	DT & Carrier send/receive logic with Carrier switch out & Carrier fail.	☐
11	Simulation of Cross-country fault in Distance function.	☐
12	Single phase initiation to LBB relay.	☐
13	3Ph trip initiation to LBB relay.	☐
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	☐
15	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	☐
16	Metering function (V, I, P, Q, Hz, PF).	☐
17	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis	☐
18	Red Ferruling in the Tripping circuit	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Transformer Feeder (Differential/REF/Backup OC&EF/Backup Impedance):

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration .	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	Differential & HV Overflux operation	☐
4	REF & LV Overflux operation	☐
5	HV OC&EF operation.	☐
6	IV/LV OC&EF operation	☐
7	Backup impedance operation	☐
8	Blocking logic for Backup impedance as per the POWERGRID requirement.	☐
9	Configuration check of 33kV Protection to the Utility feeder & Tertiary feeder availability.	☐
10	Mechanical protection logic has to be implemented as per POWERGRID standard protection logic diagram.	☐
11	Mechanical protection operation extended to Master trip operation.	☐
12	Simulation of the VT Selection logic as per the POWERGRID requirement. VT selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	☐
13	3Ph trip initiation to LBB relay.	☐
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	☐
15	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	☐
16	Metering function (V, I, P, Q, Hz, PF).	☐
17	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	☐
18	Simulation of Spare selection logic the CT switching & Tripping scheme. Spare selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	☐
19	Red Ferruling in the Tripping circuit	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Bus/Line Reactor Feeder (Differential/REF/Backup Impedance):

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	Differential operation	☐
4	REF operation	☐
5	Backup impedance operation.	☐
6	Blocking logic for Backup impedance as per the POWERGRID requirement.	☐
7	Mechanical protection logic has to be implemented as per POWERGRID standard protection logic diagram.	☐
8	NGR Bypass operation, NGR equipment alarms such as CB alarms, Closing coil alarms & output configuration as per POWERGRID requirement.	☐
9	Simulation of the VT Selection logic as per the POWERGRID requirement. VT selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	☐
10	3Ph trip initiation to LBB relay.	☐
11	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	☐
12	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	☐
13	Metering function (V, I, P, Q, Hz, PF).	☐
14	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	☐
15	Simulation of Spare selection logic the CT switching & Tripping scheme. Spare selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	☐
16	Red Ferruling in the Tripping circuit	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Centralized busbar differential relay

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	For the status of the switchgear Double point type to be considered	☐
4	**For Centralized Busbar testing refer "Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System,", DOC ref: D-2-01-03-01-XX) and simulate all logic as per the 1 ½, DM, DMT busbar scheme.**	☐
5	The report for the centralized busbar scheme has to be submitted as per the Point no 4.	☐
6	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	☐
7	Red Ferruling in the Tripping circuit	

De-Centralized busbar differential relay

Sl No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	☐
2	Correct operation of Tripping relays and associated auxiliary relays.	☐
3	For the status of the switchgear Double point type considered	☐
4	**For De-centralized Busbar testing refer "Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System, , DOC ref: D-2-01-03-01-XX) and simulate all logic as per the 1 ½, DM, DMT busbar scheme.**	☐
5	The report for the de-centralized busbar scheme has to be submitted as per the Point no 4.	☐
6	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	☐
7	Red Ferruling in the Tripping circuit	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Bay control Unit(BCU) – Feeders

Sl No.	Description	Checked
1	Interlock for the respective bays.	☐
2	Metering function (V, I, P, Q, Hz, PF).	☐
3	Graphical display of HMI page in BCU as per the SLD & their control	☐
4	Measurement of bay in HMI page as per the SLD (if Menu not available)	☐

Ethernet Switch & DR PC

Note:- If Ethernet Switch & DR PC only supplied as a part of Project without SAS, then SAS FAT procedure (DOC ref: D-2-03-20-05-XX) to be referred for checking the Performance, Document & configuration.

3. STATEMENT OF SYSTEM ACCEPTANCE

Upon successful completion of all applicable tests and the proper disposition of all documented and witnessed discrepancies resulting from tests specified in the procedure, the system, tested and witnessed by the POWERGRID, is accepted.

Note:- The approved corrected copies of the scheme drawings based on the FAT shall be submitted before SAT.

Documents Verification during FAT:

Sl No.	Description	Doc No.	Submitted
1	Visual Inspection report for each feeder		☐
2	Hardware Verification report for each feeder		☐
3	AC Scheme Check Report for each feeder		☐
4	DC Scheme Check Report for each feeder		☐
5	Auxiliary Relay Report for each feeder		☐
6	Typical configuration for each feeder verified (Line, Transformer, Bus reactor, Line reactor, Busbar)		☐
7	Specified Logic Verification-Line Feeder (Distance/Auto-reclose/LBB) Report		☐
8	Specified Logic Verification-Line Feeder (Differential/Distance/Auto reclose/LBB) Report		☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Sl No.	Description	Doc No.	Submitted
9	Specified Logic Verification-Transformer Feeder (Differential/REF/Backup OC&EF/Backup Impedance) Report		☐
10	Specified Logic verification-Bus/Line Reactor Feeder (Differential/REF/Backup Impedance) Report		☐
11	Centralised Busbar protection Report		☐
12	De-Centralised Busbar Protection Report		☐
13	Project Backup after complete FAT for all feeder configuration for all Relays involved in the FAT		☐
14	Operation and Technical Guide for Protection IEDs		☐
15	Operation and Technical Guide for BCU & other IEDs supplied		☐
16	Operation and Technical Guide IED configuration softwares		☐
17	Operation and Technical Guide Ethernet Switch		☐
18	**Other applicable equipment Operational & Technical Guide**		☐

Softwares/License details Backup:

Software/License	Doc. No.	Checked
Protection & Control each type Software & license		☐
CSD, FOTS, RTCC & Other Devices Software & license		☐
Antivirus software & license		☐
Other applicable equipment Operational & Technical Guide		☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

4. OBSERVATION AND COMPLIANCE REPORT

Observations during FAT & its compliance shall be recorded in “log sheets”.

OBSERVATION AND COMPLIANCE REPORT

LOG SHEET:

Sr. No.	Observations	Compliance	Remarks

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

5. GLOSSARY

BCU: Bay Control Unit
DR: Disturbance Recorder
EWS: Engineering Workstation
FAT: Factory Acceptance Test
FPT: Functional Performance Test
FST: Factory Simulation Test
GTW: Gateway
GPS: Global Positioning System
IED: Intelligent Electronic Device
NMS: Network Management (Monitoring) System
OWS: Operator Workstation
RCC: Remote Control Centre
RSCC: Regional System Co-ordination Centre
SAS: Sub-station Automation System
SAT: Site Acceptance Test
SCADA: System Control & Monitoring System

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

6. ANNEXURE

Annexure -PreFAT Formats

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:

पावरग्रिड POWERGRID	**Factory Acceptance Test - Protection System** **Visual Inspection**		
Manufacturer:		**Equipment:**	
Contractor:		**Feeder/Circuit:**	

VISUAL INSPECTION

Ref: FAT001

Name of the Panel:

Actions: Verify the check list and ensure that the panel under test is in line with the base document.

Sr.No.	Description	Passed	Failed
1	Ensure all the equipment are free of all foreign materials (dust, solder, droppings, etc)	☐	☐
2	Visually inspect the units and individual modules for cleanliness, healthiness and ensure that they are free from damage	☐	☐
3	Verify that the dimension of the panel as per GA	☐	☐
4	Visually inspect that the equipment are arranged as per the GA drawing of the panel (drawing pocket inside panel is available)	☐	☐
5	Verify the panel outside color and inside color is as per approved drawing	☐	☐
6	Verify the cabinet type is SWING FRAME	☐	☐
7	Verify the locker system of the panel is provided	☐	☐
8	Verify the size of the earthing bar is as per approved drawing	☐	☐
9	Verify the panel name plate and the equipment labels are correct and visible	☐	☐
10	Verify proper labeling is done for all the cables	☐	☐
11	Check for the arrangement of terminal blocks as per the drawing	☐	☐
12	Check the shorting and isolating accessories of CT terminals	☐	☐
13	Verify whether proper ferruling is done or not	☐	☐
14	Check if earth shield connections are provided	☐	☐
15	Check ventilation is provided as per the drawings	☐	☐
16	Check for proper panel door earthing	☐	☐
17	Verify paint thickness as specified in GA drawing	☐	☐
18	Check comprehensiveness of painting against external scratches, rusting, dents/damages etc.	☐	☐
19	Minimum spare TBs should be available as per TS & Truff size should be as accommodate with sufficient space for Field Cable.	☐	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

पावरग्रिड POWERGRID	**Factory Acceptance Test - Protection System** **Hardware verification**		
Manufacturer:		**Equipment:**	
Contractor:		**Feeder/Circuit:**	
		Page:	23 of 26

HARDWARE VERIFICATION TEST

Ref: FAT002

Name of the Panel:

Actions: Verify the list of equipment and ensure the identification data, manufacturer and quantities are correct.

Sr.No.	Description	Passed	Failed
1	Verify the list of equipment of the scheme drawing as per GA with the existing cubicle layout & record any non-availability of equipment	☐	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

पावरग्रिड POWERGRID	**Factory Acceptance Test - Protection System** **Hardware verification**		
Manufacturer:		**Equipment:**	
Contractor:		**Feeder/Circuit:**	
		Page:	24 of 26

AC POWER VERIFICATION

Ref: FAT003

Name of the Panel:

Actions: Verify the check list and ensure that the AC circuit of the panel is correct and the devices are working properly.

Sr.No.	Description	Passed	Failed
1	Ensure that rated AC supply is given to panel at the incoming terminals	☐	☐
2	Verify the equipment under test are rated for proper AC supply	☐	☐
3	Verify the supply at the 1phase AC supply in OFF condition	☐	☐
4	Switch ON the supply and verify the ON/OFF operation of LAMP of the cubicle by operating the miniature position switch	☐	☐
5	Verify the power supply at the socket DS is correct	☐	☐
6	Verify the power supply at the power socket is correct	☐	☐
7	Switch ON the supply and verify the operation of thermostat, heater and indicator lamp. Adjusting the thermostat settings to 25^{o}C for heater ON and ensure the Heater circuit placement doesn't affect any cable entry.	☐	☐
8	AC circuit wiring checked according to corresponding drawing	☐	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

पावरग्रिड POWERGRID	Factory Acceptance Test - Protection System Hardware verification		
Manufacturer:		**Equipment:**	
Contractor:		**Feeder/Circuit:**	
		Page:	25 of 26

DC SCHEME CHECK

Ref: FAT004

Name of the Panel:

Actions: Verify the check list and ensure that the DC circuit of thew panel is correct, and the devices are working properly.

S.No	Description	Passed	Failed
1	Ensure that rated DC supplies DC1 and DC2 are given to panel at the incoming terminals	☐	☐
2	Verify the equipment under test are rated for proper DC supply	☐	☐
3	Check continuity for DC circuit as per the drawing to ensure proper polarity before power ON	☐	☐
4	Check the Proper Co-ordination of the DC Fuse rating from the source -1 & 2 to till downstream circuit Fuse rating	☐	☐
5	Verify DC1 and DC2 at the main supply is in OFF condition. Now switch on DC Source-1. Check DC voltage at Fuse of DC Source-2. No DC voltage should be present. Switch off DC Source-1.	☐	☐
6	Verify DC1 and DC2 at the main supply is in OFF condition. Now switch on DC Source-2. Check DC voltage at Fuse of DC Source-1. No DC voltage should be present. Switch off DC Source-1.	☐	☐
7	Switch ON the DC1 and DC2 main MCBs and verify the supply at all other supply in the OFF condition	☐	☐
8	Switch ON all the supply in the panels and verify that all equipment rated for DC voltage is working properly	☐	☐
9	Perform a DC change over and ensure that no power failure happened in any of the equipment in the panel	☐	☐
10	Ensure that there is no mixing of DC1 and DC2 supply in the panel	☐	☐
11	Cubicle scheme checked according to corresponding drawing	☐	☐

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

पावरग्रिड POWERGRID	**Factory Acceptance Test - Protection System** **Hardware verification**		
Manufacturer:		**Equipment:**	
Contractor:		**Feeder/Circuit:**	
		Page:	26 of 26

Auxiliary Relay – xxxx Ref: FAT005

Feeder Reference:

1. Name Plate Rating Details of the Equipment

Record the following details of the relay.

Relay Make	
Relay Model	
Order Number	
Serial Number	
Rated Voltage	
Contacts Details	

2. General Inspection of Relay

Sr.No.	Description	Passed	Failed
1	Installation and correct wiring as per drawing	☐	☐
2	Terminal tightness	☐	☐
3	Relay earth connected to local earth bar	☐	☐

3. Secondary Injection Test

Pick-up / Drop-off Test

Inject the relay via the front panel test sockets (if possible) and record the pick-up and drop-off values in the table below.

Operating Coil

Pick-Up		Drop-Off		Result
V	mA	V	mA	

POWERGRID Representative	Manufacturer Representative
Signature:	**Signature:**
Name:	**Name:**
Date:	**Date:**

Cyber Security Requirements

1.IED Cyber Security capability compliance in the IEDs: following requirements shall be met by IED as per IEEE 1686:2013 clause 5.

Clause Number	Sub Category	Checklist
5 IED Cybersecurity features		
5.1	Electronic access control	Check the IED is protected by unique ID and Password Combination. Check it shall not be possible to gain access to the device without a proper ID/password combination that user has generated.
5.1.2	Password defeat mechanism	Check IED does not have undisclosed means whereby user-created ID/password can be defeated. Check Embedded master password technique is implemented? Check whether chip-embedded routines that automatically run in the event of hardware or software failure? Check Hardware bypass of passwords, such as jumpers and switch settings is implemented?
5.1.3	Number of Individual users	Minimum 04 users shall be supported by IED
5.1.4	Password Construction	Check password supported is At least 8 characters and is case-sensitive. When encoding is in plain text, it shall contain: -At least one uppercase and one lowercase - At least one number - One non-alpha numeric character (@,%,&,*) Check the user is notified and prompted to choose another password that conforms if it violates.
5.1.6 IED main security functions		
5.1.6 b)	View configuration settings	Check IED's ability to view configuration settings such as scaling, communication addressing, programmable logic routines(through configuration software), and firmware version
5.1.6 d)	Configuration change	Check IED's ability to **extract & upload configuration files from/to IED** to the unit and /or effect changes to the existing configuration
5.1.6 e)	Firmware change	Firmware change referes to the ability to load new firmware that does not require hardware change.
5.1.6 f)	ID/Password or RBAC management	ID/Password or RBAC management referes to the ability to load new id that does not require hardware management.
5.1.6 g)	Audit trail	Audit trail refers to the ability to view and download the audit trail.
5.1.7	Password Display	Check the vulnerability of password disclosure in local display panel, configuration software (local or remote; offline or online), web browser and terminal access
5.2 Audit trail		
5.2.4 Audit trail event types		
5.2.4 a)	Log In	Log In (locally or remotely) as a user to the device and check the event is created in audit log.
5.2.4 f)	Configuration change	Check new configuration file to the IED or new configuration parameters that causes a change in IED configuration is logged in Audit trail
5.2.4 h)	ID/password creation or modification	Check new ID/password creation/modification is logged in audit log
5.2.4 i)	ID/Password deletion	Check new ID/password deletion is logged in audit log
5.3 Supervisory monitoring and control		

5.3.1	Overview of supervisory monitoring and control	IED shall monitor security related activity and shall make the information available through a real time communication protocol for transmission to the supervisory system.
5.3.3 Alarms: Following shall cause unique alarm occurrence		
5.3.3 b)	Reboot	Rebooting or restarting of IED by means of removing power or through the use of a device resident rebooting mechanism such as reset button, power-up sequence, or access software failure.
5.3.4	Alarm point change detect	Check the momentary change of events and Alarms is detected as individual alarm and event.
5.4 IED cyber Security features		
5.4.2 Specific Cryptographic features		
5.4.2 e)	Network time synchronization	NTP shall be NTP v3/4 or SNTP 3/4
5.5 IED configuration software		
5.5.4.2 change configuration data		
5.5.4.2. a)	Full access	In full access mode, all functions, including ID/password changes and user assignment can be made.
5.6	Communications port access	Check the communication is not possible in disabled communication port and all the unused UDP/TCP ports are disabled

2.Following Security features shall be available in each IED including PMU:

- DOS protection
- NTP/PTP synchronization
- Role Based Access Control compliance as per IEC 62351-8 as per the OEM compliance chart
- Emergency access to device if connection to RBAC Server is lost
- LDAP/AD/Radius support for Authentication and account management

3. Following Security features shall be available in Computers/ workstations/ servers/software for Substation Automation System:

    - All applications(software)/ OS supplied shall be licensed to POWERGRID (if applicable) and any updates shall be supplied during the Warranty period.
    - Computer names shall be as per the standard naming convention of POWERGRID.
    - BIOS Password shall be set/enabled at system boot. Disk encryption policy shall be enabled on mobile devices(laptop/External HDD), if possible.
    - Bluetooth and Wi-Fi driver shall be uninstalled. Corresponding hardware shall be disabled from OS or BIOS, if possible.
    - Wake on LAN feature shall be disabled.
    - System boot from USB or other means shall be disabled.
    - Virtualization feature in CPU shall be disabled, wherever applicable.
    - Standard user (non-administrator) accounts shall be enabled for regular work. Privileges and use of admin privilege shall only be required for specific tasks wherever applicable.
    - Roles such as user, administrator, auditor shall be configured in IEDs and Associated applications.
    - Only whitelisted software shall be installed on systems.
    - Security features such as RBAC, password complexity, syslog, Radius/ AD authentication, enabling of certificates shall be ensured in all installed applications, wherever applicable.
    - Only whitelisted services shall be running on systems.

- External USB storage devices (i.e., pen drive, memory cards, hard disk, mobile phone storage etc.) shall NOT be allowed, only authorized USB storage devices (approved by POWERGRID) shall be allowed on systems based on the roles & requirements of the user.
- Endpoint protection (Antivirus, Anti Malware protection) shall be loaded.
- Host based firewall shall be enabled and only required ports for SAS should be opened in the host-based firewall.
- System level user password policy (password complexity & password expiry) shall also be enabled.
- IP address series will be as allocated by POWERGRID.
- All required services such as Remote Desktop (RDP), SMB, PowerShell, if required for normal operation shall be listed. Any other specific service requirement of POWERGRID will be communicated at the time of execution for listing.
- Offline backups for all systems with encryption/checksum shall be provided at the time of SAT.
- Inventory of all assets shall be carried out as per format laid down in FAT.
- Specific applications (software) used shall be as per Software Development Life Cycle/best practices. (Such as ISO/IEC 42010:2011/IEC 62443-4-1)
- Sensitive database information shall be encrypted.
- All systems shall be enabled for security logs (for OS, Application security logs and shall have the facility to be routed to a standard syslog server in compatible log formats whose IP address will be shared by POWERGRID.
- POWERGRID reserves the right to carry out VA at any point of time and vendor shall support for mitigation during warranty period as per CEA guidelines.

4. Following Security features shall be available in Network switches:
    - Discovery protocol, Web view, Telnet, TFTP shall be disabled,
    - TLSv1.2 or higher access shall be enabled.
    - User Session timeout shall be enabled. Time of logout due to user inactivity shall be configured.
    - ACL on management interfaces shall be enabled to restrict access.
    - Unused ports, proxy ARP, unused protocols shall be disabled.
    - Broadcast suppression, loop protection shall be enabled.
    - Configurable port rate limiting provision shall be provided.
    - Password complexity shall be enabled.
    - SNMPv3 or higher shall be supported.
    - MAC address-based whitelisting shall be available.
    - Availability of IEEE 802.1x based authentication

5. Following Security features shall be available in Network switches, Firewalls and Networking devices:
    - At least two roles should be configured for Network switches as per OEM role recommendation.
    - Default credentials shall be changed/ disabled.
    - Default services (i.e. FTP, HTTP, SMB, Telnet etc.) shall be disabled, if not in use. List of required services shall be verified at the time of FAT.
    - All devices shall be enabled for security logs and shall have the facility to be routed to a standard syslog server in compatible log formats whose IP address will be shared by POWERGRID.
    - Remote administration, if enabled shall be ensured with secure connection (HTTPS/ SSH) only with strong admin credentials.
    - Firmware version along with checksum, product number shall be provided.
    - Time synchronization shall be ensured.

6. Following Security features shall be available in GPS, Fault locators and other network elements:

- Roles should be configured for GPS, Fault locators and other devices .
- Default credentials shall be changed/ disabled.
- Default services (i.e. FTP, HTTP, SMB, Telnet etc.) shall be disabled, if not in use. List of required services shall be verified at the time of FAT.
- All devices shall be enabled for security logs and shall have the facility to be routed to a standard syslog server in compatible log formats whose IP address will be shared by POWERGRID.
- Remote administration, if enabled shall be ensured with secure connection (HTTPS/ SSH) only with strong admin credentials.
- Firmware version along with checksum, product number shall be provided.
- Time synchronization shall be ensured.

7. Training on cyber security should be provided by vendor including following topics but not limited to:
    - Patch management
    - Firmware update procedure
    - Perimeter threat protection
    - Configuration of endpoints
    - Security configuration of supplied devices
    - Device hardening

FAT checklist:

1.IED Cyber Security capability compliance in the IEDs: following requirements shall be met by IED as per IEEE 1686:2013 clause 5.

Clause Number	Sub-Category	Checklist	Comply/ Exception/ Exceed	Remarks
5 IED Cybersecurity features				
5.1	Electronic access control	Check the IED is protected by unique ID and Password Combination. Check it shall not be possible to gain access to the device without a proper ID/password combination that user has generated.		
5.1.2	Password defeat mechanism	Check IED does not have undisclosed means whereby user-created ID/password can be defeated. Check Embedded master password technique is implemented? Check whether chip-embedded routines that automatically run in the event of hardware or software failure? Check Hardware bypass of passwords, such as jumpers and switch settings is implemented?		
5.1.3	Number of Individual users	Minimum 04 users shall be supported by IED		
5.1.4	Password Construction	Check password supported is At least 8 characters and is case-sensitive. When encoding is in plain text, it shall contain: -At least one uppercase and one lowercase - At least one number - One non-alpha numeric character (@,%,&,*) Check the user is notified and prompted to choose another password that conforms if it violates.		
5.1.6 IED main security functions				
5.1.6 b)	View configuration settings	Check IED's ability to view configuration settings such as scaling, communication addressing, programmable logic routines(through configuration software), and firmware version		
5.1.6 d)	Configuration change	Check IED's ability to **extract & upload configuration files from/to IED** to the unit and /or effect changes to the existing configuration		
5.1.6 e)	Firmware change	Firmware change referes to the ability to load new firmware that does not require hardware change.		

5.1.6 f)	ID/Password or RBAC management	ID/Password or RBAC management referes to the ability to load new id that does not require hardware management.		
5.1.6 g)	Audit trail	Audit trail refers to the ability to view and download the audit trail.		
5.1.7	Password Display	Check the vulnerability of password disclosure in local display panel, configuration software (local or remote; offline or online), web browser and terminal access		
5.2 Audit trail				
5.2.4 Audit trail event types				
5.2.4 a)	Log In	Log In (locally or remotely) as a user to the device and check the event is created in audit log.		
5.2.4 f)	Configuration change	Check new configuration file to the IED or new configuration parameters that causes a change in IED configuration is logged in Audit trail		
5.2.4 h)	ID/password creation or modification	Check new ID/password creation/modification is logged in audit log		
5.2.4 i)	ID/Password deletion	Check new ID/password deletion is logged in audit log		
5.3 Supervisory monitoring and control				
5.3.1	Overview of supervisory monitoring and control	IED shall monitor security related activity and shall make the information available through a real time communication protocol for transmission to the supervisory system.		
5.3.3 Alarms: Following shall cause unique alarm occurrence				
5.3.3 b)	Reboot	Rebooting or restarting of IED by means of removing power or through the use of a device resident rebooting mechanism such as reset button, power-up sequence, or access software failure.		
5.3.4	Alarm point change detect	Check the momentary change of events and Alarms is detected as individual alarm and event.		
5.4 IED cyber Security features				
5.4.2 Specific Cryptographic features				
5.4.2 e)	Network time synchronization	NTP shall be NTP v3/4 or SNTP 3/4		
5.5 IED configuration software				
5.5.4.2 change configuration data				
5.5.4.2. a)	Full access	In full access mode, all functions, including ID/password changes and user assignment can be made.		

5.6	Communications port access	Check the communication is not possible in disabled communication port and all the unused UDP/TCP ports are disabled		

Verifed by:	
POWERGRID Representative	Manufacturer Representative
Signature :	Signature :
Name :	Name :
Date :	Date :

SAT checklist:

1.Configured Security features in each IED including PMU:

Sl.No	IED model	Type of protection/function	Enabled (yes/no)	Remarks
1		DOS protection		
2		NTP/PTP synchronization		
3		Role Based Access Control compliance as per IEC 62351-8 as per the OEM compliance chart (as per table 1.1)		
4		Emergency access to device if connection to RBAC Server is lost		
5		LDAP/AD/Radius support for Authentication and account management		

1.1 RBAC roles as per IEC 62351-8:

Sl.No	IED Model	Type of Role	Created (yes/no)	Remarks
1		Viewer		
2		Operator		
3		Engineer		
4		Administrator		
5		Auditor		
6		RBAC Manager		
7		Super Admin		

2. Following features are to be checked and recorded in Computers/ workstations/ servers/software for Substation Automation System:

S.no	check	Server1	Server2	HMI1	HMI2	Gateway1	Gateway2	DR PC
1.	OS Version							
2.	OS licensed version is used (yes/ no)							
3.	Computer Name							
4.	Windows update date							

5.	BIOS Password enabled (yes/No)							
6.	Check Bluetooth and Wi-Fi Driver are uninstalled.							
7.	Corresponding hardware is disabled from OS or BIOS (yes/no), if possible.							
8.	Wake on LAN feature is disabled (yes/no)							
9.	Check System boot is disabled from USB or any other means (yes/no)							
10.	Check virtualization feature in CPU is disable							
11.	Non-administrator accounts enabled for regular work							
12.	Check changes to setting like a) Boot Sequence b) Boot password c) Wake-on-Lan, d) System time etc. can be made by system admin only (yes/no)							
13.	Roles such as user, administrator, auditor are configured in IEDs and Associated applications.							
14.	Only whitelisted software are installed as per table 2.1							
15.	Security feature enabled as per table 2.2							
16.	Software license details as per table 2.3							

17.	Only whitelisted services running as per table 2.4							
18.	USB drive disabled (yes/No)							
19.	Endpoint protection (Antivirus, Anti Malware protection) loaded Yes/No							
20.	Name of Endpoint protection							
21.	Last signature update date							
22.	Host Based firewall enabled (yes/ no)							
23.	Host Based firewall configured as per whitelisted ports mentioned in 2.5 and 2.6							
24.	Centralized user management provided (yes/ No)							
25.	System level user password policy implemented (yes/ no)							
26.	Offline backups for all systems with encryption/checksum shall be provided at the time of SAT							
27.	Inventory of assets provided as per table 2.7							
28.	Sensitive database information is encrypted (yes/No)							
29.	Security logs enabled (yes/no)							

30.	Facility provided to route logs to syslog server (yes/no)							
31.	Vulnerabilities mitigated as per assessment report (yes/no)							

2.1 List of software to be whitelisted

S.NO	IED/Machine	Name of Whitelisted software

2.2 Configured Security features in software application

Sl.No	Application	feature	Enabled or not
1		RBAC	
2		Password complexity	
3		Syslog	
4		Radius/AD Authentication	
5		Enabling of certificate	

2.3 List of software including the license to POWERGRID and validity of software

S. No.	Name of Third-Party Software	License details	Expiry date of License
1			

2.4 List of Services whitelisted:

S.NO	IED/Machine	Name of Whitelisted Services

2.5 List of services and TCP/UDP port required to be running in IED/ HMI/ Gateway/ Server/ Switch/ other computers

Computer Name	Name of Services	Status (Enabled/Disabled)	By Default, status	Port	Description

2.6 List of Required TCP/UDP Open Ports (for other devices)

IED/Machine	Service	Required TCP Port	Required UDP Port	IP Address

2.7 Inventory of Assets

Specify Name of PC, Name of software, Version, Application software, database, Open-source libraries used in the development of software.

S.No	Name of PC	Software Name	Version	Use of the software	Name of Open-source library used for the development of software	Name of 3rd party library dll used for the development of software
1						

3. Check whether disk encryption policy is enabled on mobile devices (laptop/External HDD), if possible.
4. Network switches, Firewalls, and other networking devices:

	Firewall-1	Firewall-2	GPS	Fault locator 1..	Switch-1	Switch-2	…
Roles configured							
Default credentials changed/ deleted							
Default services (i.e. FTP, HTTP, SMB, Telnet etc.) disabled							
Security logging enabled							
Facility provided to route logs to syslog server (yes/no)							

Remote administration enabled (yes/no) If yes, secure connection (HTTPS/ SSH) is ensured							
Firmware details are provided as per table 4.1							
Time synchronization done (yes/No)							

4.1 Specify Firmware version, Product No and Checksum of all Network switches, Firewalls, and other devices such as GPS, Fault locators, PMU including IEDs

S.No	Name of Device	Firmware Version	Product No	Checksum MD5/SHA/SHA256 of Firm Ware
1 (e.g.)	ABB (REL 670)	1.5.0.35	1.2.3.5	
2				

Note: In some cases, there are two firmware are present in the IED. For e.g. in Siemens IEDs there are two firmware. (EN 100 firmware and other Siprotech firmware).

5. Initialize and test following Cyber Security Logs in Switches

Sl.No	Log name	Availability of log (Yes/No)	Checked log generation OK/Not OK
1.	Login successful		
2.	Logout successful		
3.	Type of login (SSH/VPN/Telnet) successful		
4.	Configuration change successful		
5.	Configuration change failed		
6.	Switch port status changed (Up/Down/disabled/enabled)		
7.	Link status		

8.	Connections denied		
9.	Connections accepted		

6. Initialize and test following Cyber security logs in GPS unit, PMU, Cameras, Applications used for configuring IEDs, BCU, any other device/ application required to generate logs:

S.NO	Description	Checked	Remark
1	Check the Structure of Security Log Entry		Below fields need to be there in the log entry but not limited to this a) Severity b) Date and Time c) IP Address or Port d) Module name & Product Name e) Message
2	Check log is generated when user log in to the system		
3	Check log is generated when user logout from the system		
4	Check log when user enter wrong credentials consecutively three times		
5	Check Log is generated when time out occurs because of inactivity		
6	Check log is generated when a admin user create other user		
7	Check log is generated when user modify the password		
8	Check log is generated when a particular user is deleted from the system		
9	Check log is generated when a control action is performed by user		
10	Check log is generated when a configuration id downloaded		

11	Check log is generated when a configuration is changed		
12	Check log is generated when firmware was changed		
13	Check log is generated when firmware was uploaded		
14	Check log is generated when audit log is viewed/downloaded		
15	Check log is generated when user changed the date and time of a system		
16	Check log is generated when link status is changed on port		
17	Check log is generated when the system restarts automatically		Additional information what triggered the restart
18	Check log is generated when a user initiated the restart		
19	Check log storage capacity of every networking equipment.		

7. Check following features in Network Switches:

Procedure

S.NO.	Description	Checked	Remark
1	Check whether Discovery Protocol is disabled or not		
2	Check whether Web View is disabled or not		
3	Check whether Telnet is disabled or not		
4	Check whether TLS1.2 or hi is enabled or not		
5	Check whether Session timeouts is enabled or not		
6	Check whether ACL on management interfaces to restrict access		
7	Check all unused ports are disabled or not		
8	Check proxy ARP is disable or not		
9	Check Port Configuration	Duplex/Auto/Full	Auto is preferred
10	Check broadcast suppression is enabled or not		
11	Check loop protection algorithm is enabled or not		
12	Check the version of SNMP.		SNMP v3 is recommended

13	Check whether all the Unused protocols are disabled or not		
14	Check for availability of IEEE 802.1x based authentication		

Verifed by:	
POWERGRID Representative	Manufacturer Representative
Signature :	Signature :
Name :	Name :
Date :	Date :

Frequently Asked Questions

A. Package Type: New Substation

1.1. What is the order of precedence of price schedule (BPS/Bid Form), technical specification and other bidding documents?

Reply:- Order of precedence of these documents to address contradictions, if any, in the contents of the bid as followings:

I. Bid Form
II. Attachment -6: deviations
III. Technical Data Sheets
IV. Any other part of the BID

Content of the documents at Sr. No. I above will have overriding precedence over other documents (Sr. no II to IV above). Similarly, content of documents at Sr. No II above will have overriding precedence over other documents (Sr. no III to IV above) and so on.

However, if adequate details are not specified in BPS, then BPS Item shall be read in conjunction with TS.

1.2. Whether Construction Power and Water at Free of cost shall be provided to the successful bidder by Employer?

Reply: - Bidder to refer clause no 14.3 of SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) which is reproduced below: -

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

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

1.3. What is the Minimum specified creepage distance to be considered for insulator string/ longrod insulators/ outdoor bushings & switchyard equipment?

Reply:- Following Standard Creepage distance is to be considered for :

a) Insulator string / longrod insulators/ outdoor bushings (GIS/Transformer/reactors)
   - For both Non-coastal area & Costal area : 31mm/kV

b) All other Switchyard Equipment-:
   - Non-coastal area : 25mm/kV
   - Costal area : 31mm/kV

1.4. Whether RTV coating in all switchyard equipment is required?

Reply:- RTV coating shall be done at site on all porcelain insulators including mandatory spares (i.e. bushings, hollow and solid insulators, disc insulators etc.) for substation(s) in coastal area (if specified in Section project). The cost of RTV coating shall be deemed to be included in the respective equipment/items' erection cost.

1.5. How the variation in the BOQ quantity shall be dealt during post award?

Reply:- Any change in BPS/LOA quantities during detailed engineering shall be dealt in line with provisions of bidding documents/Contracts.

Frequently Asked Questions

1.6. Is Special Tools and Tackles covered under present scope work?

Reply:- Bidder to refer clause no 14.2 of SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) which is reproduced below: -

"The successful bidder shall supply all special tools and tackles required for Operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are ***proprietary*** *in nature. The list of special tools and tackles, if any, shall be finalized during detail engineering and the same shall be supplied without any additional cost implication to the Employer."*

1.7. Whether SAS integration/configuration work at remote end (i.e. RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC) is envisaged under present scope of bidder.

Reply:- Necessary configuration of data at Gateway for remote operation from NTAMC, Backup NTAMC, RTAMC & supervision from RLDC/ Backup RLDC is included in present scope of bidder.
No work is envisaged at remote end (RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC) under the present scope. However successful bidder has to extend all support for successful integration of data at remote end.

1.8. Whether Approach Road is in the scope of Bidder?

Reply:- Bidder to refer clause no 13.0 pf section GTR.
As per site requirement Approach Road, in the vicinity of substation may be constructed based on drawings of internal roads enclosed with the tender drawing & Payment shall be made under unit item rate of associated BPS item for roads.

1.9. What is design temperature for battery capacity calculation as in bidding documents ambient temp is mentioned 0-50 degree?

Reply:- For Battery sizing calculations worst temp combination i.e. Zero degree is to be considered as minimum temperature for sizing calculations.

1.10. As per Scope of work capacity of battery & charger needs to be calculated considering present as well as future bays. Please provide DC load details for future CRP system.

Reply:- Bidders to consider the present bay CRP load requirement of similar feeder i.e. Transformer bay, Line/Bus Reactor Bay, Line bay, Tie bay etc for future bays also for capacity calculation of battery & charger.
If higher capacity/rating are required based on design calculations same shall be provided by contractor without additional cost to employer. However, capacity of battery & battery chargers should not be less than as specified in the BPS.

1.11. For the proposed S/S under TBCB, Kindly provide the following:-

- Coordinates of the identified land.
- Single Line Diagram,
- General Arrangement Drawing.

Reply:- It is responsibility of bidder to develop Single line diagram, General arrangement and all other associated layout considering the present as well as future scope of work for proposed Substation. SLD, Plan & General arrangement Layout of proposed substation shall be finalised during detailed Engineering based on best engineering practices, meeting the requirements of Technical Specifications & orientation of line corridors. Location/coordinates of identified land/Plot plan of proposed new substation shall be shared during detailed engineering to successful bidder.

1.12. Whether encumbrance free land will be provided to successful Bidder?

Reply:- Reasonably Encumbrance free land will be provided to successful Bidder.

1.13. Whether Line side insulator string is not in bidder's scope. Kindly confirm?

Reply:- Transmission line side insulator string along with hardware for line termination is envisaged under present scope of the bidder.

1.14. Whether space shall be provided at site for storage & site office construction at free of cost.

Reply:- It is not binding on employer to provide the space for requisite facilities. However, the same can be at substation site, on the availability of space.

1.15. Kindly provide the spacing of main Earthmat for proposed substation.?

Reply: - For estimation of risers of new substation/switchyard, maximum spacing of Main Earthmat shall be considered as below:-

- 30Mx30M for 765kV S/s
- 24Mx24M for 400kv S/s
- 16Mx16M for 220kV S/s
- 12Mx12M for 132kV switchyard respectively.

For substations with multiple voltage levels, maximum spacing of highest volage level shall be considered for estimation of risers quantities.
Actual spacing for main earthmat shall be finalized during detailed engineering based on soil resistivity data and payment shall be made as per actual executed quantity at site. However, no cost compensation shall be considered in case of actual spacing of main earthmat finalized during detailed engineering is less than that mentioned above.

1.16. Kindly provide seismic ground acceleration value & seismic zone applicable to project?

Reply:- Destination/Location is defined in bidding documents. Please refer IS-1893 Part-1 for selecting, seismic force ground acceleration value & seismic zone applicable to that location.

B. Additional Query for Package Type: Substation Extension Work

1.17. Kindly provide following details of existing Substation for TBCB projects:

- Single line diagram,
- General Arrangement drawing,
- FFPH layout etc

Reply: - Details/document , if not available in bidding documents, shall be shared with successful bidder during detailed engineering.

1.18. We presume that existing LT Switchgear viz. ACDB, DCDB, ELDB & MLDB has sufficient spare feeders to meet the present scope of Extn. bays as defined in section project.

Reply: - The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy.

1.19. Kindly provide the make and model no, availability of bay units of existing Bus bar protection scheme for present scope of work.

Reply: - The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy.

1.20. Kindly provide the make and model no, availability of licences of existing Substation automation system for present scope of work.

Reply: - The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy.
Additional licence for present scope of SAS Augmentation, is not envisaged under present scope.

1.21. Kindly provide the spacing of main Earthmat for proposed substation.?

Reply: - For estimation of riser of substation extn, main earthmat spacing shall be considered same as that in the existing switchyard. The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy.

C. Additional Query for Package Type: Transformer/Reactor Package

1.22. What shall be the procedure for long term storage of Transformer and Reactor?

Reply:- Detail procedure for storage of spare transformer unit with and without isolator switching arrangement shall be as per annexure " *Spare Transformer/Reactor Unit Storage & Connection Arrangement*" attached with Section – Transformer & reactors.

1.23. Kindly provide the distance between CMB to control panel/RTCC Panel required to estimate special cable.

Reply:- For estimation purpose CMB to control panel/RTCC Panel distance of 300mtr(approx.) shall be considered.

1.24. The Supply of 4-20mA output for OTI, WTI is in bidder's scope. Please clarify regarding the scope of integration of same in existing SCADA.

Reply:- Integration of OTI, WTI is in not in scope of transformer/Reactor Package.

D. Additional Query for Package Type: GIS

1.25. Whether LCC panels have to be placed in GIS hall or can be placed in Room adjacent to GIS hall?

Reply: - LCC panels shall be located inside the GIS hall itself preferably in front of respective GIS bay. CRP panel (Protection panels) shall be placed in Local Control Relay Room (LCR room) adjacent to GIS hall.

1.26. Kindly confirm the requirement of EOT Crane for 765kV, 400kV, 220kV & 132kV GIS Halls?

Reply:- One EOT Crane(As per BPS) of suitable capacity in line with technical specifications for each 765kV, 400kV, 220kV & 132kV GIS Halls-

1.27 How many Air change per Hour requirement for ventilation of the GIS Hall?

Reply:- The ventilation of the GIS hall shall be of a positive pressure type with minimum 2 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure.

1.27. What is the minimum clearance requirement between GIB and any building?

Reply:- The horizontal clearance between GIB and GIS building /any other building wall shall be preferably be three (3) meters.

1.28. During extension of GIS Substation, OEM representative of existing GIS, tools & tackles required for extn work & Consumable items for existing GIS is in whose scope?

Reply:- During Extension of existing GIS substation, tools and tackles as well as consumables/gaskets, etc. as required & also OEM representative of existing GIS (for supervising connection of the Interface Module), shall be arranged by the present bidder/contractor without any additional financial implication to Owner/Employer.