

Technical Specification

Section-General Technical Requirement

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1 INTRODUCTION:

The provisions under this section are intended to supplement requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive.

2 GENERAL REQUIREMENT:

2.1 **All equipment/materials/items, as per Annexure-X, 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. The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

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.

- 2.2 It is recognized that the Contractor may have standardized the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer’s standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Employer.
- 2.3 Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.
- 2.4 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components which are minor in nature and incidental to the requirement but not specifically stated in the specification and bid price schedule, which are necessary for commissioning and satisfactory operation of the switchyard/ substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.
- 2.5 The Contractor shall also be responsible for the overall co-ordination with internal /external agencies; Supplier of Employer’s supplied equipment, project management, training of Employer’s manpower, loading, unloading, handling, insurance, moving to destination for

successful erection, testing and commissioning of the substation /switchyard.

- 2.6 The Contractor shall be responsible for safety of humans and equipment during the working. **It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning.** Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Employer.

3 STANDARDS

- 3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.
- 3.2 The equipment offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standards, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification at [Annexure-III](#) is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for equipment/material, then other applicable international standard (IEC/Equivalent), as per the specification, shall be accepted.
- 3.3 The Contractor shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves but intended to complement each other.
- 3.4 When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.5 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under [Annexure-III](#)/ individual sections for various equipment shall also, be accepted, however the salient points of difference shall be clearly brought out during detailed engineering along with English language version of such standard. The equipment conforming to standards other than specified under [Annexure-III](#)/ individual sections for various equipment shall be subject to Employer's approval.

4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED:

- 4.1 Switching surge over voltage and power frequency over voltage is specified in the system parameters below. In case of 400kV system, the initial value of the temporary over voltages could be 2.0 pu for 1-2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc. under such overvoltage conditions.
- 4.2 All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.
- 4.4 The Contractor shall design terminal connectors of the equipment considering various forces as mentioned above that are required to withstand.
- 4.5 The equipment shall also comply to the following:
 - i. To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - ii. All piping, if any between equipment control cabinet/operating mechanism to

marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 System Parameter:

765kV, 400kV & 220kV System:

S. No.	Description of parameters	765kV System	400kV System	220kV System
1.	System operating voltage	765kV	400kV	220kV
2.	Maximum operating voltage of the system (rms)	800kV	420kV	245kV
3.	Rated frequency	50HZ		
4.	No. of phase	3		
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 μsec)	± 2100kV _p	± 1550kV _p	± 1050kV _p
ii)	Switching impulse withstand voltage (250/2500 μsec) dry and wet	± 1550kV _p	± 1050kV _p	-
iii)	One minute power frequency dry withstand voltage (rms)	830kV	630kV	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	-	-	460kV
6.	Corona extinction voltage	508kV	320kV	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2MHz	2500 μV at 508kV _{rms}	1000 μV at 266kV _{rms}	1000 μV at 156kV _{rms}
8.	Minimum creepage - for Equipment other than Insulator string/ long rod insulators/ outdoor bushings	25mm/kV (31mm/kV for coastal area)		
	Minimum creepage - for Insulator String/ long rod insulators/ outdoor bushings	31mm/kV		
9.	Min. clearances			
i.	Phase to phase	7600 mm (For conductor-conductor configuration) 9400 mm (For rod-conductor configuration)	4000 mm (For conductor-conductor configuration) 4200 mm (For rod -conductor configuration)	2100 mm
ii.	Phase to earth	4900 mm (For conductor-structure) 6400 mm (for rod- structure)	3500 mm	2100 mm
iii.	Sectional clearances	10300 mm	6500 mm	5000 mm
10.	Rated short circuit current for 1 sec. duration	50kA	63 kA	50kA
11.	System neutral earthing	Effectively earthed		

132kV, 66kV, 52kV, 33kV & 11kV System:

S. No.	Description of parameters	132 kV System	66 kV System	52 kV System	33 kV System	11kV System
1.	System operating voltage	132kV	66kV	52kV	33kV	11kV
2.	Maximum operating voltage of the system(rms)	145kV	72.5kV	52kV	36kV	12kV
3.	Rated frequency	50Hz				
4.	No. of phase	3				
5.	Rated Insulation Levels					
i.	Full wave impulse withstand voltage (1.2/50 μ sec.)	650kV _p	325kV _p	250kV _p	170kV _p	75kV _p
ii.	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	95kV	70kV	28kV
6.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	500 μ V at 92kV _{rms}	-	-	-	-
7.	Minimum creepage distance*	25mm/kV (31mm/kV for coastal area)				
8.	Min. Clearance					
i.	Phase to phase	1300 mm	750 mm	530 mm	320 mm	280 mm
ii.	Phase to earth	1300 mm	630 mm	480 mm	320 mm	140 mm
iii.	Sectional clearances	4000 mm	3100 mm	3100 mm	3000 mm	2800 mm
9.	Rated short circuit current	40/31.5kA for 1 sec	31.5/25kA for 3 sec**	25kA for 1 Sec	25 kA for 3 sec	25 kA for 3 sec
10.	System neutral earthing	Effectively earthed				

Notes:

- The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable as per relevant IEC/IS.
- The insulation and RIV levels of the equipment shall be as per values given in the Technical Specification of respective equipment.
- Corona, radio interference voltage test and seismic withstand test procedures for equipment shall be in line with the procedure given at [Annexure-I](#) and [Annexure-II](#) respectively.
- “*” For 145kV voltage level, creepage distance shall be 31mm/kV for Insulator String/ long rod insulators/ outdoor bushings etc.
- “**” For tertiary loading Equipment, fault level shall be 25kA for 3 Sec. For other switchyard equipment shall be as specified in Section project.
- Coastal Area is to be considered only, if defined in Section project.

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 sources 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
- vi) Sustained wind specific to coastal Region
- vii) Landslides incidences with Annual rainfall normal
- viii) District wise Probable Max. Precipitation

5 ENGINEERING DATA AND DRAWINGS:

- 5.1 The list of drawings/documents which are to be submitted to the Employer is enclosed in [Annexure-V](#). In case any additional drawings/documents are required, the same shall also be submitted during execution of the contract.
- 5.2 The contractor shall submit all engineering Documents (Drawings/Design documents/data/detailed bill of quantity/ type test reports) through E-mail/online portal (as available) for the approval of the employer.
- 5.3 Drawings:
 - i. All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.
 - ii. Drawings submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. Employer has standardized many drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings along with type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per the provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.
 - iii. The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under

the specifications, external connections and of the dimensions which might affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated, or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements specified under these specifications and documents.

- iv. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.
- v. All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

5.4 Approval Procedure:

The following schedule shall be followed generally for approval and for providing final documentation.

S. No.	Description	Time required
1	Approval/comments/ by Employer on initial submission	As per L2 schedule
2	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
3	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
4	Furnishing of distribution copies (2 hard copies to each and one scanned copy (pdf format)	2 weeks from the date of approval substation
5	Furnishing of distribution copies of test reports	
i	Type test reports (one scanned softcopy in pdf format to each substation plus one for corporate center & one hardcopy per substation)	2 weeks from the date of final approval
ii	Routine Test Reports (one copy for each substation)	-do-
6	Furnishing of instruction/ operation manuals (2 copies per substation and one softcopy (pdf format) for corporate center & per substation)	On completion of Engineering
7	As built drawings (two sets of hardcopies per substation & one softcopy (pdf format) for Head office & per substation)	On completion of entire works

NOTE:

- (1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) All drawings should be submitted through E-mail/online portal (as available), further substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire

substation in case of substation extension also.

For civil drawings associated documents shall be submitted in STAAD/excel format in addition to submission through E-mail/online portal (as available).

- (3) The Instruction Manual shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
 - (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.
 - (5) The Contractor shall be furnished to the Employer catalogues of spare parts.
 - (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.
- 5.5 The list of major drawings/documents to be approved to qualify for second advance in accordance with the conditions agreed in SCC, shall be as per [Annexure-IV](#).

6 MATERIAL/ WORKMANSHIP:

6.1 General Requirement:

- i. Where the specification does not contain references to workmanship, equipment, materials, and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.
- ii. In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer, the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed, or used without such approval shall run the risk of subsequent rejection, it is to be understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.
- iii. The design of the Works shall be such that installation, future expansions, replacements, and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed, and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.
- iv. Whenever possible, all similar parts of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
- v. All materials and equipment shall be installed in strict accordance with the

manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

- vi. The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.
- vii. All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare source of oil/grease /other consumables in the GTP/Drawings, where such oil or grease is available. He shall help Employer in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.2 Provisions For Exposure to Hot and Humid climate:

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall, and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of the same type.

i. Space Heaters:

- The heaters shall be suitable for continuous operation at 240V as supply voltage. An on- off switch and fuse shall be provided.
- One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

ii. Fungi Static Varnish:

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

iii. Ventilation opening:

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the

entry of dirt and dust.

iv. **Degree of Protection:**

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall comply with following degree of protection as detailed here under:

- a. Installed outdoor: **IP- 55**
- b. Installed indoor in air-conditioned area: **IP-31**
- c. Installed in covered area: **IP-52**
- d. Installed indoor in non-air-conditioned area where possibility of entry of water is limited: **IP-41**
- e. For LT Switchgear (AC & DC distribution Boards): **IP-52**

The degree of protection shall be in accordance with IEC 60947 and IEC 60529. Type test report for of relevant Degree of Protection test, shall be submitted for approval.

6.3 Rating Plates, Name Plates and Labels:

- i. Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved Manufacturer's name, Customer Name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Employer. The rating plate of each equipment shall be according to IS/ IEC requirement.
- ii. All such Name plates, Instruction plates, Rating plates of Transformers, Reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipment shall be bilingual with Hindi inscription first followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 First fill of consumable, oil and lubricants:

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7 DESIGN IMPROVEMENTS / COORDINATION:

- 7.1 The bidder shall offer the equipment meeting the requirement of the technical specification. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the contractor & Employer agree upon any such changes, the specification shall be modified accordingly.
- 7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof shall be deemed to have been amended accordingly.
- 7.3 The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and

maintenance.

- 7.4 The Contractor must coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Employer. The names of agencies shall be intimated to the successful bidders.
- 7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's, and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at the Employer office, Noida (U.P.) or at mutually agreed venue as and when required and fully cooperate with such people and agencies involved during those discussions.

8 QUALITY ASSURANCE PROGRAMME:

- 8.1 To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance program to control such activities at all points necessary. A quality assurance program of the Contractor shall be in line with ISO requirements & shall generally cover the following:
 - a. The organization structure for the management and implementation of the proposed quality assurance program.
 - b. System for Document and Data Control.
 - c. Qualification and Experience data of Bidder's key personnel.
 - d. The procedure for purchases of materials, parts, components, and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
 - e. System for shop manufacturing and site erection controls including process controls, fabrication, and assembly control.
 - f. System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feedback received from the Customers and internally documented system for Customer complaints.
 - g. Inspection and test procedure both for manufacture and field activities.
 - h. System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
 - i. System for indication and appraisal of inspection status.
 - j. System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.
 - k. System for authorizing release of manufactured product to the Employer.
 - l. System for maintenance of records.
 - m. System for handling, storage, and delivery.
 - n. A quality plan detailing the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
 - o. System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records.

In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipment as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The Contractor shall ensure availability of the following Quality Assurance Documents:

- a. All Non-Destructive Examination procedures, stress relief and weld repair procedure used during fabrication, and reports including radiography interpretation reports.
- b. Welder and welding operator qualification certificates.
- c. Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- d. Raw Material test reports on components as specified by the specification and in the quality plan.
- e. The Manufacturing Quality Plan (MQP) indicates Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- f. Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- g. Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE:

- i. The contractor shall procure bought out items from sub-vendors as per the list approved by the Employer. The contractor shall explore first the possibilities of procuring the bought-out items from Employer approved vendors. In case of their unavailability / non-response, Contractor may approach Employer for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per [Annexure-VI](#) 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. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, Employer 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.

The responsibility and the basis of inspection for various items & equipment is placed at [Annexure-VII](#) along with the requirement of MQP (Manufacturing Quality Plan), ITP (Inspection & Test Plan), FAT (Factory Acceptance Test) which should be valid & Employer 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 Employer, MQP shall be generally submitted as per Employer format before placing order.

Items not covered under MQP/ITP/FAT as per Inspection levels, shall be offered for

inspection as per Employer LOA/Technical Specifications/ Employer approved data sheets/ Employer 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 Employer or its authorized representative, involvement of Employer for inspection of various items / equipment will be based on the level below:

Level –I: MQP envisaged, MQP approval by Employer. In Stage Inspection and Final Inspection by Employer / Employer appointed Third Party Inspection authorized agency. If the Inspection and test results are found satisfactory, formal Quality Clearance Note (QCN) to be issued.

If Employer provides inspection waiver, Supplier / Supplier Quality services shall conduct the inspection and submit the reports for review.

Level – II: MQP envisaged, MQP approval by Employer. Inspection by Supplier / Supplier's Third-party Inspection authorized agency. Advance inspection call anticipated prior to inspection. Inspection report shall be submitted to Employer for issuance of QCN.

Level - III: MQP not envisaged. No Physical Inspection envisaged. Dispatch clearance based on Material Test Reports / Certificates. Inspection call to be raised along with Test Certificates. Based on the certificates from Supplier, Employer will issue QCN after reviewing reports.

- ii. 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).
- iii. 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 the Works, 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 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 Employer shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.
- iv. 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 Seven (7) working 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)/ Customer Hold Point (CHP) for indigenous inspections. All inspection calls for overseas material should 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 shall forthwith forward to the Inspector three copies of tests, duly certified. The contractor shall ensure, before giving notice for the type test, that all drawings and quality plans have been approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Instructions in writing by the Employer. QCN 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, the test will be carried out as per approved QAP and the test certificate will be furnished by the supplier for approval. QCN will be issued only after review and approval of the test reports.

- v. The contractor shall generally offer material for inspection as per supply schedule approved by the Employer and not before 30 days from schedule indicated. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of Employer, Employer shall inspect the material. However, in such an exceptional case, QCN shall be issued only as per provision of original / revised approved supply schedule.
- vi. Contractors shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.
- vii. Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for Employer inspection and shall also ensure that relevant portion of LOA, 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.
- viii. The contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 15 days in case of domestic supplies and within 30 days in case of Off shore supplies from the date of issuance of QCN. **Material which is not dispatched within stipulated time as above will be reoffered for Employer inspection or specific approval of Employer QA&I shall be obtained for delayed dispatch.**
- ix. 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.
- x. All Test Reports and documents to be submitted in English during final inspection of equipment by Employer or as and when required for submission.

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 Employer IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from 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.

- xi. 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 labor, 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.
- xii. **The inspection and acceptance by Employer and issue of QCN thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance program forming a part of the Contract, or if such equipment is found to be defective at a later stage.**
- xiii. 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 complies with the specification.
- xiv. The Employer reserves the right to get any additional field tests conducted on the completely assembled equipment on site to satisfy that material complies with specifications.
- xv. 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 Employer for approval, before taking up the Re-Work/Re-Engineering, failing which Employer reserves the right to reject the equipment.
- xvi. 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 Employer 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 Employer approved Third Party Laboratories.
- xvii. Contractor shall ensure that all possible steps are taken to avoid damage to the equipment during transport, storage and erection.
- xviii. **Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per Employer approved guidelines/Technical specifications.**
- xix. Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.
- xx. For EHV transformers/reactors:

Insulation oil shall be as per Employer's/CEA's 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-conditioner 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 and 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.

- xxi. 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.

9 TYPE TESTING & CLEARANCE CERTIFICATE:

- 9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.
- 9.2 The reports for all types tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipment/ material already accepted by Employer shall be applicable for all projects with similar requirements. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by Employer /representative authorized by Employer /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 LOA. In case the test reports are of the test conducted earlier than the years specified below from the date of LOA, the contractor shall repeat these test(s) at no extra cost to the Employer.

S. No	Name of Equipment	Validity of type test (in years)
1	Power Transformer/ Shunt Reactor/ LT Transformer	5
2	OLTC	10
3	Bushing of Power Transformers/Reactors	7
4	Fittings and accessories for Power Transformers & Reactors	10
5	Circuit Breaker/ Isolator/ Instrument transformer/ Lighting Arrester/ Wave Trap	10
6	GIS & Hybrid GIS	15
7	LT Switchgear/ Battery & Battery Charger	10
8	Cable and associated accessories	10
9	Relays/CSD/DTPC/PMU/Communication equipment	7
10	Capacitors	10
11	Conductor & Earth wire	10
12	High temperature (HT)/High temperature low sag (HTLS) conductor	7
13	Insulators (Porcelain/Glass)	10

14	Composite Insulators	5
15	PLCC/FO Cable/OPGW	5

Note: For all other equipment's validity of type test shall be 10 years from date of LOA

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 at least two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

- 9.3 The Employer intends to repeat those type tests which are indicated in the price schedule and the same shall be payable as per provision of contract. The price of conducting type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.
- 9.4 The Employer reserves the right to witness any or all the type tests. The Employer shall bear all expenses for deputation of Employer's representative(s) for witnessing the type tests except in the case of re-deputation if any, necessitated due to no fault of the Employer.
- 9.5 The list of makes of various items, for which Type test reports are not required to be submitted are specified at [Annexure-IX](#).

10 TESTS:

10.1 Pre-commissioning Tests:

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance program.

10.2 Commissioning Tests:

- i. The available instrumentation and control equipment will be used during such tests and the Employer will calibrate all such measuring equipment and devices as far as practicable.
- ii. Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be arranged by the Contractor at his own cost.
- iii. The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.
- iv. **Pre-commissioning, Commissioning, Trial-Run & Completion:**

As soon as the facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the

Facilities, as mentioned below, shall be attained in accordance with the agreed during detailed engineering.

- (i) Pre-commissioning : As per pre-commissioning format
- (ii) Commissioning : Charging of the Facilities at rated voltage.

Further, wherever appearing in these specifications, the words ‘commissioning checks’, ‘installation checks’, ‘site tests’, ‘performance guarantee tests for fire protection system’, are to be considered as ‘pre commissioning checks.’

- (iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 24 (Twenty-four) hours continuously. In case of interruption due to problem/failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 24 (twenty-four) hours period start after such rectification.

- (iv) Completion : Upon successful completion of Trial-run.

‘Guarantee Test(s)’ and/or ‘Functional Guarantees’ are applicable only for Substation Automation System as specified in Section - Substation Automation System.

- 10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard.

11 PACKAGING & PROTECTION:

- 11.1 All the equipment shall be suitably protected, coated, covered or boxed and created to prevent damage or deterioration during transit, handling and storage at site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Employer to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.
- 11.2 All coated surfaces shall be protected against abrasion, impact, discoloration, and any other damage. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12 FINISHING OF METAL SURFACES:

- 12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot dip galvanized after fabrication. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.
- 12.2 Hot Dip Galvanising:

- i. The minimum weight of the zinc coating shall be 610 gm/m² and minimum average thickness of coating shall be 86 microns and above **900 gm/m² for coastal area (if defined in Section-Project)** for all items having thickness 6mm or above. For items lower than 6mm thickness, requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/m² minimum and **900 gm/m² for coastal area (if specified in Section-Project)**.
- ii. The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- iii. After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment except that nuts may be threaded after galvanizing. Sodium dichromate or alternate approved treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- iv. The galvanized steel shall be subjected to four numbers of one-minute dips in copper sulphate solution as per IS: 2633.
- v. Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
 - Coating thickness
 - Uniformity of zinc
 - Adhesion test
 - Mass of zinc coating
- vi. Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of touch-up zinc rich paint at site shall be allowed with approval of Engineer In charge.

12.3 PAINTING:

- i. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 “Code of practice for phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- ii. Hot Phosphating shall be done for phosphating process under pretreatment of sheets. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.
- iii. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

- iv. The exterior and interior color of the paint in case of new substations shall preferably be **RAL 7032** for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipment. **Glossy white color** inside the equipment /boards /panels/junction boxes is also acceptable. The exterior color for panels shall match the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.
- v. In case the contractor proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted during detailed engineering for Employer's review & approval.
- vi. The color scheme as given below shall be followed for Fire Protection and Air Conditioning systems:

S. No.	PIPELINE	Base color	Band color
<u>Fire Protection System</u>			
1	Hydrant and Emulsifier system pipeline/ NIFPS	FIRE RED	-
2	Emulsifier system detection line – Water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
<u>Air Conditioning Plant</u>			
1	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
2	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
3	Refrigerant liquid pipeline	Dark Admiralty Green	-
4	Chilled water pipeline	Sea Green	-
5	Condenser water pipeline	Sea Green	Dark Blue

- vii. For aluminum cast surfaces, the surface shall be smooth finish. Further, in case of aluminum enclosures, the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting. For stainless steel surfaces, no painting is envisaged.
- viii. Band color is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band color shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.

13 HANDLING, STORING AND INSTALLATION:

- 13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energization at rated voltage.

- 13.2 Contractors may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- 13.3 **The contractor must ensure that the open storage platform is constructed for storage of outdoor type equipment/material prior to commencement of delivery at site.** Outdoor equipment shall be stored on open storage platform, properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress.

However, all indoor equipment including control & protection panels, Communication equipment and operating mechanism boxes etc. of outdoor equipment shall be stored indoors.

Storage of equipment on top of another one is not permitted if the wooden packing is used and there is possibility of equipment/packing damage. Material opened for joint inspection should be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.
- 13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- 13.6 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. **The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks.** However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be in the account of the Contractor.
- 13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damage etc.
- 13.8 Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.10 The words 'erection' and 'installation' used in the specification are synonymous.

- 13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service's life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.
- 13.13 Equipment Bases
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
- 13.14 **Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipment, NIFPS System etc. shall be done by the contractor under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BOQ.**

14 TOOLS:

14.1 Tools & Plants (T&P)

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damage shall be to the account of contractor.

All such T&P shall be taken back by the contractor after commissioning of the system.

14.2 Special Tools and Tackles

The contractor 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 detailed engineering and the same shall be supplied without any additional cost implication to the Employer.

14.3 Facilities To Be Provided by The Employer (As specified in Section-Project)

- i. Employers 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 non-availability or 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.
- ii. Employers 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.

15 AUXILIARY SUPPLY:

- 15.1 The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc. shall be designed for the specified Parameters as below. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following table:

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral Connection
415V	$\pm 10\%$	$50 \pm 5\%$	3/4 Wire	Solidly Earthed.
240V	$\pm 10\%$	$50 \pm 5\%$	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	Isolated 2 wire System	-
110V	95V to 120V	DC	Isolated 2 wire System	-
48V	--	DC	2 wire system (+) earthed	-

Combined variation of voltage and frequency shall be limited to $\pm 10\%$.

- 15.2 Pickup value of binary input modules of Intelligent Electronic Devices, Digital protection couplers, Analog protection couplers **shall not be less than 50%** of the specified rated station auxiliary DC supply voltage level.

16 SUPPORT STRUCTURE:

- 16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e. **14.0-meter, 8.0-meter, 5.9 meter and 4.6 meter from plinth level for 765kV, 400kV, 220kV and 132kV substations respectively**. All equipment support structures shall be supplied along with brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.
- 16.2 The minimum vertical distance from the bottom of the lowest porcelain/polymer part of the bushing, porcelain/polymer enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be **2.55 meters**.

17 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS:

- 17.1 All power clamps and connectors shall conform to IS:5561 or other equivalent international standard and shall be made of materials listed below:

S. No.	Description	Materials
a	For connecting ACSR conductors/ AAC conductors/ Aluminum tube	Aluminum alloy casting, conforming to designation 4600 of IS:617 and all tests shall conform to IS:617
b	For connecting equipment terminals mad of copper with ACSR conductors/AAC conductors/ Aluminium tube	Bimetallic connectors made from aluminum alloy casting, conforming to designation 4600 of IS:617 with 2mm thick bimetallic liner/strip and all tests shall conform to IS:617
c	For connecting G. I	Galvanized mild steel shield wire
d	Bolts, nuts & plain washers	Electro-galvanized for sizes below M12, for others hot dip galvanized.
e	Spring washers	Electro-galvanized mild steel suitable for at least service condition-3 as per IS:1573

- 17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

- 17.3 Where copper to aluminum connections is required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.
- 17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each case, are also included in the scope of Work.
- 17.5 **Current carrying part of any clamp shall not be less than 10 mm thick.** All ferrous parts shall be hot dip galvanized. Copper alloy liner/strip of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic liner/strips shall be provided for Bi-metallic clamps.
- 17.6 All casting shall be free from blow holes, surface blisters, cracks, and cavities. All sharp edges and corners shall be blurred and rounded off.
- 17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion and through (fixed/sliding) type connection of IPS AL tube as required. In both the cases the clamp height (top of the mounting pad to center line of the tube) should be same.
- 17.8 **Current carrying parts (500A and above) of the clamp/connector shall be provided with minimum four numbers of bolts preferably for 132kV and above.**
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Power Clamps and connectors shall be designed to control corona as per requirement.
- 17.11 **Tests:**

Clamps and connectors should be type tested on minimum three samples as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. **Type test conducted once, shall hold good. The requirement of tests conducted within last ten years shall not be applicable.**

- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
- ii) Short time current test
- iii) Corona (dry) and RIV (dry) test [for 132kV and above voltage level clamps]
- iv) Resistance test and Pullout strength test
- v) Cantilever Strength test on bus support clamps & connectors.

18 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES, MARSHALLING BOXES FOR OUTDOOR EQUIPMENT:

- 18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC 61439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, marshalling boxes & terminal boxes, Outdoor ACDB cum DCDB panels shall be made of **stainless steel of at least 1.5 mm thick or aluminum enclosure of at least 1.6 mm thick** and shall be dust, water, and vermin proof. Stainless steel used shall be of **grade SS304 (SS316 for coastal area)** or better. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In the case of aluminum enclosed box, the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

Control cabinets, junction boxes, marshalling boxes & terminal boxes, out-door ACDB cum DCDB panels shall have adequate space/clearance as per guidelines/technical specifications to access/replace any component. Necessary component labelling also needs to be done on non-conducting sheets.

For Control cabinets, Junction Boxes, Terminal boxes, marshalling boxes for outdoor equipment Junction Box, wire should be as per IS or equivalent IEC with FRLSH grade.

Machine laid PU Foam gasket may be permitted for use in Control Cabinets etc.

- 18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rainwater.

- 18.4 **Cabinet/boxes with width more than 700 mm shall be provided with double hinged doors with padlocking arrangements.** The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere.

- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene/PU gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400/ISO:37. Ventilating Louvers, if provided, shall have screens and filters. The screen shall be fine wire mesh made of brass.

Further, the gasketing arrangement shall be such that gaskets are pasted in slots (in door fabrication/gasket itself) to prevent ingress of dust and moisture inside the panels so that no internal rusting occurs in panels during the operation of the equipment.

- 18.6 All boxes/cabinets shall be designed for the entry of cables by means of weatherproof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel-plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armor of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

- 18.7 A 240V, single phase, 50 Hz, 15-amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection to hand lamps. Plug and socket shall be of industrial grade.

- 18.8 **LED-based illumination of minimum 9 watts shall be provided.** The switching of the fittings shall be controlled by the door switch.

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

- 18.10 Earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured using self-etching washer. Earthing of hinged door shall be done by using a separate earth wire.

- 18.11 The bay marshalling kiosks shall be provided with danger plates and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

- 18.12 The following routine tests along with the routine tests as per IS:5039 shall also be

conducted:

- i) Check for wiring.
- ii) Visual and dimension check

18.13 The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IEC 60947 **including application of 1kV rms for 1 (one) minute, after IP-55 test.**

19 DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE:

After completion of the work, Contractor shall dispose-off all the packing & waste materials including empty conductor drums, cable drums, wooden containers, oil drums, gas cylinders and other waste/scrapped materials from construction site at his own cost and shall make the substation area properly cleaned.

20 TERMINAL BLOCKS AND WIRING:

- 20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.
- 20.2 **Terminal blocks shall be 650V grade** and have continuous rating to carry the maximum expected current on the terminals and non-breakable type. These shall be molded pieces, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But the terminal blocks shall be non-disconnecting stud type except for the secondary junction boxes of Current Transformer and Voltage Transformer.
- 20.3 **Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities.** The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.
- 20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel-plated copper or zinc plated steel shall also be acceptable.
- 20.6 The terminal blocks shall be of extensible design, **multilayer terminal arrangement is not allowed in any junction box** (Common MB, Individual MB, JB etc.). There should be sufficient space at both sides of terminals so that ferrule number of wires / TB numbers are clearly visible during wire removal or insertion.
- 20.7 The terminal blocks shall have locking arrangements to prevent its escape from the mounting rails.
- 20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a) All circuits except CT/PT circuits	Minimum of Two of 2.5 mm ² Copper flexible.
b) All CT/PT circuits	Minimum of Four of 2.5 mm ² Copper flexible.

- 20.10 The arrangements shall be made in such a manner that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.
- 20.11 At least **10% of spare terminals** shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminal's rows.
- 20.12 **There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.**
- 20.13 The Contractor shall furnish all wire, conduits, and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

21 LAMPS & SOCKETS:

21.1 Lamps & Sockets:

All lamps shall use a socket base as per IS: 1258, except in the case of signal lamps.

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 240 Volts, Single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection to hand lamps.

21.3 Switches and Fuses:

- i. Each panel shall be provided with necessary arrangements for receiving, distributing, isolating, and fusing DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switch fuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.
- ii. All fuses shall be of HRC cartridge type conforming to relevant IS mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:

- 22.1 Bushings shall be manufactured and tested in accordance with IEC 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155. The support insulators shall be manufactured and tested as per IEC 60168 and IEC 60273. The insulators shall also conform to IEC 60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC 61462.

- 22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

- 22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

- 22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength, and rigidity for the conditions under which they will be used.
- 22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- 22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- 22.7 All iron parts shall be hot dip galvanized and all joints shall be airtight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.
- 22.8 **RTV Coating on porcelain insulators (for coastal area):**
- RTV coating shall be done at site on all porcelain insulators (i.e. bushings, hollow and solid insulators, disc insulators etc.) for substation(s) in coastal area if defined in section Project. The cost of RTV coating shall be deemed to be included in the respective equipment/items' erection cost. The technical details of RTV coating is attached in [Annexure-VIII](#).

23 MOTORS:

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

- a. Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoors, i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.
- b. Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c. Motors shall have drain plugs located so that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d. Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

- a. Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be overloaded at any operating point of driven equipment that will rise in service.
- b. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

- a. All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b. Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c. The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:12615.
- d. Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
- e. The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

- a. The maximum permissible temperature rise over the ambient temperature of 50 °C shall be within the limits specified in IS:12615 (for 3-phase induction motors) after adjustment due to increased ambient temperature specified.
- b. The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- c. All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING:

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation Resistance.
- (b) Phase sequence and proper direction of rotation.
- (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24 TECHNICAL REQUIREMENT OF EQUIPMENTS:

Following equipment shall be offered from the Indian Manufacturing facilities of manufacturer(s)

who meets the technical requirements as stipulated here, provided the same equipment are not covered under the Bidder's Qualifying requirement of the Bidding Documents.

Legend:

- * : voltage class of respective equipment as applicable.
- # : **satisfactory operation** means certificate issued by the Employer/Utility certifying the operation without any adverse remark.
- @ : **Circuit Breaker Bay** means 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 disconnecter and three nos. of single phase CTs / Bushing CTs

LOA: Letter of Award

24.1 Technical requirements for 765/400/220/132/110kV* Air Insulated Switchgear (AIS) Equipment* (i.e. Circuit Breaker, Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)

- (i) The manufacturer(s) whose 765/400/220/132/110kV* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132/110kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of LOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that-
 - a) 715/345/220/132/110kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of LOA.
 - 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 equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% 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.

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 at least two (2) years as on the date of LOA.
- (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 LOA.

- 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 3% 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.

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 at least two (2) years as on the date of LOA.

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 at least two (2) years as on the date of LOA.

- (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, type tested (as per IEC/IS standard) and same should have been supplied as on the date of LOA.
 - 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 **3%** 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.

24.4 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:

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	applicable for supply of 400kV class Transformer
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	applicable for supply of 220kV class Transformer
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	applicable for supply of 132kV class Transformer

These Transformer(s) must have been in satisfactory operation# for at least two (2) years as on the date of LOA.

(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 132kV class 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 LOA.
- 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 3% 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.

24.5 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:

345kV or above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1- phase Shunt Reactors, each having capacity of at least 16.7 MVAR	applicable for supply of 400kV class Reactors
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	applicable for supply of 220kV class Transformer
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	applicable for supply of 132kV class Transformer

These Reactor(s) must have been in satisfactory operation# for at least two (2) years as on the date of LOA.

- (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 LOA.
 - 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 3% 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.

24.6 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 at least 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for at least 2 (two) years as on the date of LOA.
- (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 at least one (1) year as on the date of LOA.

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 LOA.

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 3% of the ex-works cost of the equipment(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

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 at least 5 (five) km of single core, 220kV/132kV/110kV* or higher grade XLPE insulated cable which must be in

operation for at least 2 (two) years as on the date of LOA.

- (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 at least one (1) year as on the date of LOA.

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 LOA.

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 3% of the ex-works cost of the equipment(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

24.8 Technical Requirement for 66kV 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 at least 5 (five) km of single core, 66kV or higher grade XLPE insulated cable which must be in satisfactory operation# for at least two (2) years as on the date of LOA.
- (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 66kV or higher grade XLPE insulated cable, and which must be in satisfactory operation# for at least one (1) year as on the date of LOA.

24.9 Technical Requirement for 1.1 KV Grade PVC Control Cable:

The manufacturer(s), whose PVC control cables are offered, must have designed, manufactured, tested, and supplied in a single contract at least 100 Kms of 1.1kV grade PVC insulated control cables as on the date of LOA. Further the manufacturer must also have designed, manufactured, tested, and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the date of LOA.

24.10 Technical Requirement for 1.1 KV Grade PVC Power Cable:

The manufacturer(s), whose PVC Power Cables are offered, must have designed, manufactured, tested, and supplied in a single contract at least 100 Kms of 1.1kV or higher-grade PVC insulated power cables as on the date of LOA. Further the manufacturer must also have designed, manufactured, tested, and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the date of LOA.

24.11 Technical Requirement for 1.1 KV Grade XLPE Power Cables:

The manufacturer(s), whose XLPE Power cables are offered, must have designed,

manufactured, tested, and supplied in a single contract at least 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of LOA. Further the manufacturer must also have designed, manufactured, tested, and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the date of LOA.

24.12 Technical Requirement for LT Switchgear:

- i) The manufacturer whose LT Switchgear(s) are offered, must be a manufacturer of LT Switchboards of the type and rating being offered. He must have designed, manufactured, tested and supplied at least 50 nos. draw-out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He must have also manufactured at least 50 nos. MCC panels comprising of MCCBs (i.e. Molded Case Circuit Breakers) modules of the type offered which must be in satisfactory operation[#] as on the date of LOA.
- ii) The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design, at least one hundred circuit breakers of the make and type being offered must have been in satisfactory operation[#] as on the date of LOA.

24.13 Technical Requirements for Battery

The manufacturer whose Batteries are offered, must have designed, manufactured, and supplied DC Batteries of the type specified and being offered, having a capacity of at least 600 AH and these must be satisfactory operation[#] for at least two (2) years in power sector or industrial installations as on the date of LOA.

24.14 Technical Requirements for Battery Charger:

The manufacturer, whose Battery Chargers are offered, must have designed, manufactured and supplied Battery Chargers generally of the type offered, with static automatic voltage regulators and having a continuous output of at least ten (10) KW and these must have been in satisfactory operation[#] as on the date of LOA.

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 at least 33kV class of 315kVA or higher. The transformer must have been in satisfactory operation[#] for at least two (2) years as on the date of LOA.
- (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 LOA.

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 3% 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.

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 LOA.
- (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-
 - 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 LOA.
 - Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipment(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

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 3% 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.

24.17 Technical Requirements for Control, Relay & Protection System and Sub-station Automation System:

The manufacturer whose Control, Relay & Protection System (Control & protection Intelligent Electronic Devices (IEDs)), and Sub-station Automation System (as applicable) are offered, must have designed, manufactured, tested, installed and commissioned Control, Relay & Protection system along with Sub-station Automation System which must have been in satisfactory operation# on (i) 400 kV system [applicable for 765kV substation] & (ii) specified voltage level or above [applicable for 400kV & below substation] for at least two (2) years as on the date of LOA.

AND

The Manufacturer or their joint venture or subsidiary company or parent company must be a manufacturer of control and protection IEDs and must have established repair, testing and integration (at least for 4 bays) facilities for Control, Relay & Protection System and Sub-station Automation System in India.

24.18 Technical Requirements for analog and digital PLCC panels (765kV, 400kV, 220kV & 132kV):

- (i) The manufacturer whose PLCC panels are offered, must have designed, manufactured, tested, supplied and commissioned PLCC panels for (i) 400kV system or above [applicable for 765 kV & 400 kV substation], (ii) 220 kV System or above [applicable for 220 kV Substation] & (iii) 132 kV system or above [applicable for 132 kV

substation] and the same must have been in satisfactory operation# for at least two (2) years as on the date of LOA.

- (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) PLCC panels must have been 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 LOA.
 - b) collaborator shall furnish performance guarantee for an amount of 3% 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.
 - c) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply PLCC panels in India, shall be submitted.

24.19 Technical Requirement of Communication Equipment:

The SDH equipment shall be offered from a manufacturer(s) who is a “Local Supplier” as per DPIIT PP notification & has been Manufacturing SDH equipment for the last three (3) years and SDH equipment Manufactured by such manufacturer(s) shall have been satisfactory operation in 110kV or higher voltage Power Substations for at least two (2) years as on the date of LOA.

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 LOA.
- (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) At least 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 LOA.
 - 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 3% 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.

ANNEXURE-I: CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General:

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

- 3.1 RIV tests shall be made according to measuring circuit as per International Special- Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.
- 3.2 Alternatively, RIV tests shall be carried out in accordance with relevant IEC of respective equipment or NEMA standard Publication No. 107-1987.
- 3.3 In measurement of RIV, temporary additional external corona shielding may be provided. In measurements of RIV, only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.
- 3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. **RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified.** The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.
- 3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.
- 3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona:

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test

voltage is raised and lowered to determine their precise values. **The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued, and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 3 times with corona inception and extinction voltage recorded each time.** The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the three values at which visible corona (negative or positive polarity) disappears.

The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

However, both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Employer's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1987 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in microvolts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

ANNEXURE-II: SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (for 400kV and above) shall be carried out along with supporting structure. Seismic Withstand Test carried out using either lattice or pipe structure is acceptable.” **Seismic Calculations certified by NABL Labs would also be acceptable.**

The Bidder shall arrange to transport the structure from his Contractor’s premises/ Employer sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Employer. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Employer.

The frequency range for the earthquake spectra shall be as per IEC 62271-300.

ANNEXURE-III: LIST OF GENERAL STANDARDS AND CODES

CODES	TITLE
--	India Electricity Rules
--	Indian Electricity Act
--	Indian Electricity (Supply) Act
--	Indian Factories Act
IS-5	Colors for Ready Mixed Paints and Enamels
IS-335	New Insulating Oils
IS-617	Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purposes
IS-1448 (P1 to P 145)	Methods of Test for Petroleum and its Products
IS-2071 (Part-1)	Methods of High Voltage Testing
IS-2165 (Part-1:1977)	Insulation Coordination
IS-3043	Code of Practice for Earthing
IS-6103	Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids
IS-6104	Method of Test for Interfacial Tension of Oil against Water by the Ring Method
IS-6262	Method of test for Power factor & Dielectric Constant of Electrical Insulating Liquids
IS-6792	Method for determination of electric strength of insulating oils
IS-5578	Guide for marking of insulated conductors
IS-11353	Guide for uniform system of marking & identification of conductors & apparatus terminals.
IS-8263	Methods for Radio Interference Test on High voltage Insulators
IS-9224 (Part 1,2&4)	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	High Voltage Test Techniques
IEC 60068	Environmental Test
IEC-60117	Graphical Symbols
IEC-60156	Method for the Determination of the Electrical Strength of Insulation Oils
IEC-60270	Partial Discharge Measurements
IEC-60376	Specification and Acceptance of New Sulphur Hexafluoride
IEC-60437	Radio Interference Test on High Voltage Insulators
IEC-60507	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems
IEC-62271-1	Common Specification for High Voltage Switchgear & Control gear Standards
IEC-60815	Guide for the Selection of Insulators in respect of Polluted Conditions
IEC-60865 (P1 & P2)	Short Circuit Current - Calculation of effects
ANSI-C.1/NFPA.70	National Electrical Code

ANSI-C37.90A	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21, C63.3	Specification for Electromagnetic Noise and Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	Techniques for Dielectric Tests
ANSI-C76.1/EEE21	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings
ANSI-SI-4	Specification for Sound Level Meters
ANSI-Y32-2/C337.2	Drawing Symbols
ANSI-Z55.11	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	General Standards for Industrial Control and Systems Part ICSI- 109
CISPR-1	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements
TRANSFORMERS AND REACTORS	
IS:10028 (Part 2 & 3)	Code of practice for selection, installation & maintenance of Transformers (P1:1993), (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	Power Transformers
IS-3347 (part 1 to Part 8)	Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres
IS-3639	Fittings and Accessories for Power Transformers
IS-6600	Guide for Loading of oil immersed Transformers
IEC-60076 (Part 1 to 5)	Power Transformers
IEC-60214	On-Load Tap-Changers
IEC-60289	Reactors
IEC- 60354	Loading Guide for Oil - Immersed power transformers
IEC-60076-10	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise
ANSI-CG,1EEE-4	Standard Techniques for High Voltage Testing

IEC 60076	Power transformers
IEC 60076-1	Part 1: General
IEC 60076-2	Part 2: Temperature rise
IEC 60076-3	Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4	Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-3-1	Part 3-1: Insulation Levels and Dielectric Tests –External Clearances in Air
IEC 60076-5	Part 5: Ability to withstand short circuit
IEC 60076-6	Part 6: Reactors
IEC 60076-7	Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8	Part 8: Application guide
IEC 60076-10	Part 10: Determination of sound levels
IEC 60076-10-1	Part 10-1: Determination of sound levels - Application guide
IEC 60076-11	Part 11: Dry-type transformers
IEC 60076-12	Part 12: Loading guide for dry-type power transformers
IEC 60076-13	Part 13: Self-protected liquid-filled transformers
IEC 60076-14	Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
IEC 60076-15	Part 15: Gas-filled power transformers
IEC 60076-16	Part 16: Transformers for wind turbine applications
IEC 60076-18	Part 18: Measurement of frequency response
IEC 60076-19	Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC 60076-21	Part 21: Standard requirements, terminology, and test code for step-voltage regulators
IEC 60044, BS 3938	Current transformers
IEC 60050	International Electrotechnical Vocabulary
IEC 60050(421)	International Electrotechnical vocabulary- Chapter 421: Power Transformers and Reactors
IEC 60060	High Voltage test techniques
IEC 60060-1	General definitions and test requirements
IEC 60060-2	Measuring systems
IEC 60071	Insulation co-ordination
IEC 60071-1	Part 1: Definitions, principles and rules
IEC 60071-2	Part 2: Application guide
IEC 60137	Bushing for alternating voltage above 1000V
IEC 60214	On-Load Tap changers
IEC 255-21-3	Relays vibration
IEC 60270	Partial discharge measurements
IEC 60296	Specification for Unused Mineral Oil for Transformers and Switchgear

IEC 60422	Supervision and Maintenance guide for Mineral Insulating Oil in Electrical Equipment
IEC 60475	Method of Sampling Liquid dielectrics
IEC 60529	Classification of Degrees of Protection provided by Enclosures
IEC 60542	Application Guide for On-Load Tap-Changers
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment for the Analysis of Free and Dissolved Gases
IEC 60651	Sound Level Meters
IEC 61083	Digital Recorders and Software for High Voltage Impulse testing
IEC 61083-1	Part 1: Requirements for digital recorders in high voltage impulse tests
IEC 61083-2	Part 2: Evaluation of software used for the determination of the parameters of impulse waveforms
CISPR 16	Specification for radio disturbance and immunity measuring apparatus
CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR-18	Radio Interference Characteristics of Power Lines and High Voltage Equipment
ISO 9001	Quality system-Model for Quality Assurance in Design /Development
CIGRE Publication 202	Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above. August 2002-Cigre Working Group 12.22
WG 12-15	Guide for Customers Specifications for Transformers 100 MVA and 123 kV and above
WG 12 19	Short Circuit Performance of Transformers.
BS-4360	Specification for weldable structural steel
BS-5135	Specification for arc welding of carbon and carbon manganese steels
BS-5500	Specification for unfired fusion welded pressure vessels
IS-3618	Specification for phosphate treatment of iron & steel for protection against corrosion
IS-6005	Code of practice for phosphating of Iron and Steel
ISO-8501	Preparation of steel surface before application of Paints and related product
IEC-60599	Mineral oil impregnated electrical equipment in service – guide to the interpretation of dissolved and free gases analysis
IS-10593	Method of evaluating the analysis of gases in oil filled electrical equipment in service
IS-2099	Bushings for alternating voltages above 1000 volts

IS-3347 Part I to 8	Dimension for porcelain transformer bushing
DIN-42530	Bushing up to 1000kV from 250A-5000A for liquid filled Transformer
IS-2026 Part 1 to 5	Power transformer
IS-4691	Degrees of protection provided by enclosure for rotating electrical machinery
IEC-60034-5	Degrees of protection provided by integral design of rotating electrical machines (IP Code) classification
IS:325 / IEC -60034	Performance of cooling fan / oil pump motor
IS-13947 part 1 to 5	Specification for low voltage switchgear and control gear
IS:3400	Methods of test for vulcanized rubber
IS:7016 part 1 to 14	Methods of test for coated and treated fabrics
IS:803	Code of practice for design, fabrication, and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:3637	Gas operated Relays
IS:335	New Insulating oils – Specification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas-insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IS:3400 / BS 903 / IS:7016	Air cell (Flexible Air Separator)
IEC 60529 / IP: 55	Degree of protection for cooler control cabinet, MOLG, Cooling fan, oil pump, Buchholz Relay
IEC 60529 / IP: 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP: 43	Degree of protection for Remote tap Changer cubicle (RTCC)
CIRCUIT BREAKERS	
IEC-62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC-62271-101	High-voltage switchgear and control gear - Part 101: Synthetic testing
IEC-62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
IEC-62271-110	High-voltage switchgear and control gear - Part 110: Inductive load switching
IEC-62271-109	High-voltage switchgear and control gear - Part 110: Inductive load switching
CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR	
VOLTAGE TRANSFORMERS	
IS-2705- (P1 to P4)	Current Transformers
IS:3156- (P1 to P4)	Voltage Transformers

IS-4379	Identification of the Contents of Industrial Gas Cylinders
IEC-61869 (Part-1)	Instrument transformers - Part 1: General requirements
IEC-61869 (Part-2)	Instrument transformers - Part 2: Additional requirements for current transformers
IEC-61869 (Part-3)	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
IEC-61869 (Part-4)	Instrument transformers - Part 4: Additional requirements for combined transformers
IEC-61869 (Part-5)	Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers
IEC-61869 (Part-6)	Instrument transformers - Part 6: Additional general requirements for low-power instrument transformers
IEC-61869 (Part-9)	Instrument transformers - Part 9: Digital interface for instrument transformers
IEC-61869 (Part-102)	Instrument transformers - Part 102: Ferro resonance oscillations in substations with inductive voltage transformers
IEC-61869 (Part-103)	Instrument transformers - The use of instrument transformers for power quality measurement
BUSHING	
IS-2099	Bushings for Alternating Voltages above 1000V
IEC-60137	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS	
IS-3070 (PART2)	Lightning arresters for alternating current systems: Metal oxide lightning arrestors without gaps
IEC 60099-4	Metal oxide surge arrestors without gaps
IEC 60099-5	Selection and application recommendation
ANSI-C62.1	IEEE Standards for S A for AC Power Circuits
NEMA-LA 1	Surge Arresters
CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS	
IS-722, IS-1248	Electrical relays for power system
IS-3231, 3231 (P-3)	Protection
IS:5039	Distributed pillars for Voltages not Exceeding 1000 Volts
IEC 60068.2.2	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC 60529	Degree of Protection provided by enclosures
IEC 60947-4-1	Low voltage switchgear and control gear
IEC 61095	Electromechanical Contactors for household and similar purposes
IEC 60439 (P1 & 2)	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	Switchgear Assemblies, including metal enclosed bus
ANSI-C37.50	Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39	Electric Measuring instrument

ANSI-C83	Components for Electric Equipment
IS: 8623: (Part I to 3)	Specification for Switchgear & Control Assemblies
NEMA-AB	Molded Case Circuit and Systems
NEMA-CS	Industrial Controls and Systems
NEMA-PB-1	Panel Boards
NEMA-SG-5	Low voltage Power Circuit breakers
NEMA-SG-3	Power Switchgear Assemblies
NEMA-SG-6	Power switching Equipment
NEMA-5E-3	Motor Control Centers
1248 (P1 to P9)	Direct acting indicating analogue electrical measuring instruments & their accessories
Disconnecting switches	
IEC 62271-102	High-voltage switchgear and control gear - Part 102: Alternating current disconnectors and earthing switches
IEC 60265 (Part 1 & 2)	High Voltage switches
ANSI-C37.32	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	Test Code for high voltage air switches
NEMA-SG6	Power switching equipment
PLCC and line traps	
IS-8792	Line traps for AC power system
IS-8793	Methods of tests for line traps
IS-8997	Coupling devices for PLC systems
IS-8998	Methods of test for coupling devices for PLC systems
IEC 60353	Line traps for A.C. power systems
IEC 60481	Coupling Devices for power line carrier systems
IEC 60495	Single sideboard power line carrier terminals
IEC 60683	Planning of (single Sideband) power line carrier systems
CIGRE	Tele protection report by Committee 34 & 35
CIGRE	Guide on power line carrier 1979
CCIR	International Radio Consultative Committee
CCITT	International Telegraph & Telephone Consultative Committee
EIA	Electric Industries Association
Protection and control equipment	
IEC 60051: (P1 to P9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories
IEC 60255 (Part 1 to 23)	Electrical relays
IEC 60297 (P1 to P4)	Dimensions of mechanical structures of the 482.6mm (19 inches) series
IEC 60359	Expression of the performance of electrical & electronic measuring equipment
IEC 60387	Symbols for Alternating-Current Electricity meters

IEC 60447	Man, machine interface (MMI) - Actuating principles
IEC 60521	Class 0.5, 1 and 2 alternating current watt hour meters
IEC 60547	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	Screw threads
ANSI-B18	Bolts and Nuts
ANSI-C37.1	Relays, Station Controls etc.
ANSI-C37.2	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	Requirements for electrical analog indicating instruments
MOTORS	
IS-325	Three phase induction motors
IS-4691	Degree of protection provided by enclosure for rotating electrical machinery
IEC 60034 (P1 to P19:)	Rotating electrical machines
IEC-Document 2	Three phase induction motors
(Central Office) NEMA-MGI	Motors and Generators
Electronic equipment and components	
MIL-21B, MIL-833 & MIL-2750	Environmental testing
EC 60068 (P1 to P5)	Printed boards
IEC 60326 (P1 to P2)	Material and workmanship standards
IS-1363 (P1 to P3)	Hexagon head bolts, screws, and nuts of product grade C
IS-1364 (P1 to P5)	Hexagon head bolts, screws and nuts of products grades A and B
IS-3138	Hexagonal Bolts and Nuts (M42 to M150)
ISO-898	Fasteners: Bolts, screws and studs
ASTM	Specification and tests for materials
Clamps & connectors	
IS-5561	Electric power connectors
NEMA-CC1	Electric Power connectors for sub station
NEMA-CC 3	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors
Bus hardware and insulators	
IS: 2121	Fittings for Aluminum and steel cored Al conductors for overhead
	power lines
IS-731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V
IS-2486 (P1 to P4)	Insulator fittings for overhead power lines with a nominal voltage

	greater than 1000 V
IEC 60120	Dimensions of Ball and Socket Couplings of string insulator units
IEC 60137	Insulated bushings for alternating voltages above 1000 V
IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V
IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC 60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC 61462	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC 60305	Insulators for overhead lines with nominal voltage above 1000V- ceramic or glass insulator units for ac systems Characteristics of String Insulator Units of the cap and pin type
IEC 60372 (1984)	Locking devices for ball and socket couplings of string insulator units: dimensions and tests
IEC 60383 (P1 and P2)	Insulators for overhead lines with a nominal voltage above 1000 V
IEC 60433	Characteristics of string insulator units of the long rod type
IEC 60471	Dimensions of Clevis and tongue couplings of string insulator units
ANSI-C29	Wet process porcelain insulators
ANSI-C29.1	Test methods for electrical power insulators
ANSI-C92.2	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	Iron and steel hardware
CISPR-7B	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	Zinc Coating (Hot-Dip) on iron and steel hardware
Strain and rigid bus-conductor	
IS-2678	Dimensions & tolerances for Wrought Aluminum and Aluminum Alloys drawn round tube
IS-5082	Wrought Aluminum and Aluminum Alloy Bars. Rods, Tubes and Sections for Electrical purposes
ASTM-B 230-82	Aluminum 1350 H19 Wire for electrical purposes
ASTM-B 231-81	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	Aluminum - Alloy extruded bar, rod, wire, shape
ASTM-B 236-83	Aluminum bars for electrical purpose (Busbars)
ASTM-B 317-83	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)

Batteries	
IS:1651	Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)
IS:1652	Stationary Cells and Batteries, Lead-Acid Type (with Plante Positive Plates)
IS:1146	Rubber and Plastic Containers for Lead-Acid Storage Batteries
IS:6071	Synthetic Separators for Lead-Acid Batteries
IS:266	Specification for Sulphuric Acid
IS:1069	Specification for Water for Storage Batteries
IS:3116	Specification for Sealing Compound for Lead-Acid Batteries
IS:1248	Indicating Instruments
IS:10918	Vented type nickel Cadmium Batteries
IEC 60896-21&22	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC 60623	Vented type nickel Cadmium Batteries
IEC 60622	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC 60623	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC 60896-11	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	Sizing of Ni-Cd Batteries
IEEE-1187	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	Guide for selection of VRLA Batteries
Battery Charger	
IS:3895	Mono-crystalline Semiconductor Rectifier Cells and Stacks
IS:4540	Mono-crystalline Semiconductor Rectifier Assemblies and Equipment
IS:6619	Safety Code for Semiconductor Rectifier Equipment
IS:2026	Power Transformers
IS:2959	AC Contactors for Voltages not Exceeding 1000 Volts
IS:1248	Indicating Instruments
IS:2208	HRC Fuses
IS:13947 (Part-3)	Air brake switches, air break disconnectors & fuse combination units for voltage not exceeding 1000V AC or 1200V DC
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:6005	Code of practice for phosphating of Iron and Steel

IS:3231	Electrical relays for power system protection
IS:3842	Electrical relay for AC Systems
IS:5	Colors for ready mix paint
IEEE-484	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations
IEEE-485	Sizing large lead storage batteries for generating stations and substations
Wires and cables	
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IS-694	PVC insulated cables for working voltages upto and including 1100 Volts
IS-1255	Code of practice for installation and maintenance of power cables, upto and including 33 kV rating
IS-1554 (P1 and P2)	PVC insulated (heavy duty) electric cables (part 1) for working voltage upto and including 1100 V Part (2) for working voltage from 3.3 kV upto and including 11kV
IS:1753	Aluminium conductor for insulated cables
IS:2982	Copper Conductor in insulated cables
IS-3961 (P1 to P5)	Recommended current ratings for cables
IS-3975	Mild steel wires, formed wires and tapes for armoring of cables
IS-5831	PVC insulating and sheath of electric cables
IS-6380	Elastomeric insulating and sheath of electric cables
IS-7098	Cross linked polyethylene insulated PVC sheathed cables for working voltage up to and including 1100 volts
IS-7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltage from 3.3kV up to and including 33 kV
IS-8130	Conductors for insulated electrical cables and flexible cords
IS-1753	Aluminum Conductors for insulated cables
IS-10418	Specification for drums for electric cables
IEC 60096 (part 0 to p4)	Radio Frequency cables
IEC 60183	Guide to the Selection of High Voltage Cables
IEC 60189 (P1 to P7)	Low frequency cables and wires with PVC insulation and PVC sheath
IEC 60227 (P1 to P7)	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V
IEC 60228	Conductors of insulated cables
IEC 60230	Impulse tests on cables and their accessories
IEC 60287 (P1 to P3)	Calculation of the continuous current rating of cables (100% load factor)
IEC 60304	Standard colors for insulation for low-frequency cables and wires

IEC 60331	Fire resisting characteristics of Electric cables
IEC 60332 (P1 to P3)	Tests on electric cables under fire conditions
IEC 60502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	Tests on gases evolved during combustion of electric cables
AIR conditioning and ventilation	
IS-659	Safety code for air conditioning
IS-660	Safety code for Mechanical Refrigeration
ARI:520	Standard for Positive Displacement Refrigeration Compressor and Condensing Units
IS:4503	Shell and tube type heat exchanger
ASHRAE-24	Method of testing for rating of liquid coolers
ANSI-B-31.5	Refrigeration Piping
IS:2062	Steel for general structural purposes
IS:655	Specification for Metal Air Dust
IS:277	Specification for Galvanized Steel Sheets
IS-737	Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS-1079	Hot rolled cast steel sheet & strip
IS-3588	Specification for Electrical Axial Flow Fans
IS-2312	Propeller Type AC Ventilation Fans
BS-848	Methods of Performance Test for Fans
BS-6540 Part-I	Air Filters used in Air Conditioning and General Ventilation
BS-3928	Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	Method of cold DOP & hot DOP test
MIL-STD-282	DOP smoke penetration method
ASHRAE-52	Air cleaning device used in general ventilation for removing particle matter
IS:3069	Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials
IS:4671	Expanded Polystyrene for Thermal Insulation Purposes
IS:8183	Bonded Mineral Wool
IS:3346	Evaluation of Thermal Conductivity properties by means of guarded hot plate method
ASTM-C-591-69	Standard specification for rigid preformed cellular urethane thermal insulation
IS:4894	Centrifugal Fans
BS:848	Method of Performance Test for Centrifugal Fans
IS:325	Induction motors, three-phase
IS:4722	Rotating electrical machines
IS:1231	Three phase foot mounted Induction motors, dimensions of

IS:2233	Designations of types of construction and mounting arrangements of rotating electrical machines
IS:2254	Vertical shaft motors for pumps, dimensions of
IS:7816	Guide for testing insulation resistance of rotating machines
IS:4029	Guide for testing three phase induction motors
IS: 4729	Rotating electrical machines, vibration of, Measurement and evaluation of
IS:4691	Degree of protection provided by enclosures for rotating electrical machinery
IS:7572	Guide for testing single-phase ac motors
IS:2148	Flame proof enclosure for electrical apparatus
BS:4999(Part-51)	Noise levels
Galvanizing	
IS-209	Zinc Ingot
IS-2629	Recommended Practice for Hot-Dip galvanizing on iron and steel
IS-2633	Methods for testing uniformity of coating of zinc coated articles
ASTM-A-123	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips
ASTM-A-121-77	Zinc-coated (Galvanized) steel barbed wire
Painting	
IS-6005	Code of practice for phosphating of iron and steel
ANSI-Z551	Gray finishes for industrial apparatus and equipment
SSPEC	Steel structure painting council
Fire protection system	
--	Fire protection manual issued by tariff advisory committee (TAC) of India
HORIZONTAL CENTRIFUGAL PUMPS	
IS:1520	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	Code for acceptance test for centrifugal & axial pumps
IS:5120	Technical requirement – Rotodynamic special purpose pumps
API-610	Centrifugal pumps for general services Hydraulic Institutes Standards
BS:599	Methods of testing pumps
PTC-8.2	Power Test Codes - Centrifugal pumps
DIESEL ENGINES	
IS:10000	Methods of tests for internal combustion engines
IS:10002	Specification for performance requirements for constant speed compression ignition engines for general purposes (above 20 kW)
BS:5514	The performance of reciprocating compression ignition (Diesel) engines, utilizing liquid fuel only, for general

	purposes
ISO:3046	Reciprocating internal combustion engines performance
IS:554	Dimensions for pipe threads where pressure tight joints are required on threads
ASME Power Test Code	Internal combustion engine PTC-17
--	Codes of Diesel Engine Manufacturer's Association, USA
PIPING VALVES & SPECIALITIES	
IS:636	Non percolating flexible fire-fighting delivery hose
IS:638	Sheet rubber jointing and rubber inserting jointing
IS:778	Gun metal gate, globe and check valves for general purpose
IS:780	Sluice valves for water works purposes (50 to 300 mm)
IS:901	Couplings, double male and double female instantaneous pattern for fire fighting
IS:902	Suction hose couplings for fire-fighting purposes
IS:903	Fire hose delivery couplings branch pipe nozzles and nozzle spanner
IS:1538	Cast iron fittings for pressure pipes for water, gas and sewage
IS:1903	Ball valve (horizontal plunger type) including floats for water supply purposes
IS:2062	SP for weldable structural steel
IS:2379	Color Code for the identification of pipelines
IS:2643	Dimensions of pipe threads for fastening purposes
IS:2685	Code of Practice for selection, installation and maintenance of sluice valves
IS:2906	Sluice valves for water-works purposes (350 to 1200 mm size)
IS:3582	Basket strainers for fire-fighting purposes (cylindrical type)
IS:3589	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS:4038	Foot valves for water works purposes
IS:4927	Unlined flax canvas hose for fire fighting
IS:5290	Landing valves (internal hydrant)
IS:5312 (Part-I)	Swing check type reflex (non-return) valves
IS:5306	Code of practice for fire extinguishing installations and equipment on premises
Part-I	Hydrant systems, hose reels and foam inlets
Part-II	Sprinkler systems
BS:5150	Specification for cast iron gate valves
MOTORS & ANNUNCIATION PANELS	
IS:325	Three phase induction motors
IS:900	Code of practice for installation and maintenance of induction motors
IS:996	Single phase small AC and universal electric motors

IS:1231	Dimensions of three phase foot mounted induction motors
IS:2148	Flame proof enclosure of electrical apparatus
IS:2223	Dimensions of flange mounted AC induction motors
IS:2253	Designations for types of construction and mounting arrangements of rotating electrical machines
IS:2254	Dimensions of vertical shaft motors for pumps
IS:3202	Code of practice for climate proofing of electrical equipment
IS:4029	Guide for testing three phase induction motors
IS:4691	Degree of protection provided by enclosure for rotating electrical machinery
IS:4722	Rotating electrical machines
IS:4729	Measurement and evaluation of vibration of rotating electrical machines
IS:5572	Classification of hazardous areas for electrical (Part-I) installations (Areas having gases and vapours)
IS:6362	Designation of methods of cooling for rotating electrical machines
IS:6381	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	Guide for testing insulation for rotating machine
IS:4064	Air break switches
IEC DOCUMENT 2 (Control Office) 432	Three Phase Induction Motor
VDE 0530 Part I/66	Three Phase Induction Motor
IS:9224 (Part-II)	HRC Fuses
IS:6875	Push Button and Control Switches
IS:694	PVC Insulated cables
IS:1248	Indicating instruments
IS:375	Auxiliary wiring & busbar markings
IS:2147	Degree of protection
IS:5	Color Relay and timers
IS:2959	Contactors
PG Test Procedures	
NFPA-13	Standard for the installation of sprinkler system
NFPA-15	Standard for water spray fixed system for the fire protection
NFPA-12A	Standard for Halong 1301 Fire Extinguishing System
NFPA-72E	Standard on Automatic Fire Detectors
--	Fire Protection Manual by TAC (Latest Edition)
NFPA-12	Standard on Carbon dioxide extinguisher systems
IS:3034	Fire of industrial building
--	Electrical generating and distributing stations code of practice
IS:2878	CO2 (Carbon dioxide) Type Extinguisher
IS:2171	DC (Dry Chemical Powder) type

IS:940	Pressurized Water Type
D.G. SET	
IS:10002	Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes
IS:10000	Method of tests for internal combustion engines
IS:4722	Rotating electrical machines-specification
IS:12063	Degree of protection provided by enclosures
IS:12065	Permissible limit of noise levels for rotating electrical machines
--	Indian Explosive Act 1932
Steel structures	
IS-228 (1992)	Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.
IS-802 (P1 to 3)	Code of practice for use of structural steel in overhead transmission line towers
IS-806	Code of practice for use of steel tubes in general building construction
IS-808	Dimensions for hot rolled steel beam, column channel and angle sections
IS-814	Covered electrodes for manual arc welding of carbon of carbon manganese steel
IS-816	Code of Practice for use of metal arc welding for general construction in Mild steel
IS-817	Code of practice for training and testing of metal arc welders. Part 1: Manual Metal arc welding
IS-875 (P1 to P4)	Code of practice for design loads (other than earthquake) for buildings and structures
IS-1161	Steel tubes for structural purposes
IS-1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS-1363 (P1 to P3)	Hexagonal head bolts, screws & nuts of products grade C
IS-1364	Hexagon head bolts, screws and nuts of product grades A and B
IS-1367 (P1 to P18)	Technical supply condition for threaded steel fasteners
IS-1599	Methods for bend test
IS-1608	Method for tensile testing of steel products
IS-1893	Criteria for earthquake resistant design of structures
IS-1978	Line Pipe
IS-2062	Steel for general structural purposes
IS-2595	Code of practice for Radiographic testing
IS-3063	Single coil rectangular section spring washers for bolts, nuts and screws
IS-3664	Code of practice for ultrasonic pulse echo testing by contact and immersion methods
IS-7205	Safety code for erection of structural steel work

IS-9595	Recommendations for metal arc welding of carbon and carbon manganese steels
ANSI-B18.2.1	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-G8.14	Round head bolts
ASTM-A6	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	Specifications of structural steel
ASTM-A47	Specification for malleable iron castings
ASTM-A143	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242	Specification for high strength low alloy structural steel
ASTM-A283	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	Specification for High strength low alloy structural manganese vanadium steel
ASTM-A572	Specification for High strength low alloy columbium-Vanadium steel of structural quality
AWS D1-0	Code for welding in building construction welding inspection
AWS D1-1	Structural welding code
AISC	American institute of steel construction
NEMA-CG1	Manufactured graphite electrodes
Piping and pressure vessels	
IS-1239 (Part 1 and 2)	Mild steel tubes, tubulars and other wrought steel fittings
IS -3589	Seamless Electrically welded steel pipes for water, gas and sewage
IS-6392	Steel pipe flanges
ASME	Boiler and pressure vessel code
ASTM-A120	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	Seamless carbon steel pipe for high temperature service
ASTM-A284	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction
ASTM-A234	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	Forgings, carbon steel for piping components
ASTM-A307	Carbon steel externally threaded standard fasteners

ASTM-A193	Alloy steel and stainless-steel bolting materials for high temperature service
ASTM-A345	Flat rolled electrical steel for magnetic applications
ASTM-A197	Cupola malleable iron
ANSI-B2.1	Pipe threads (Except dry seal)
ANSI-B16.1	Cast iron pipe flanges and flanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	Factory-made wrought steel butt welding fittings
ANSI-B16.11	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	Ferrous pipe plug, bushings, and locknuts with pipe threads
ANSI-B16.25	Butt welding ends
ANSI-B18.1.1	Fire hose couplings screw thread
ANSI-B18.2.1	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-B18.21.1	Lock washers
ANSI-B18.21.2	Plain washers
ANSI-B31.1	Power piping
ANSI-B36.10	Welded and seamless wrought steel pipe
ANSI-B36.9	Stainless steel pipe
Other civil works standards	
IS-269	33 grade ordinary Portland cement
IS2721	Galvanized steel chain link fence fabric
IS-278	Galvanized steel barbed wire for fencing
IS-383	Coarse and fine aggregates from natural sources for concrete
IS-432 (P1 and P2)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
IS-456	Code of practice for plain and reinforced concrete
IS-516	Method of test for strength of concrete
IS-800	Code of practice for general construction in steel
IS-806	Steel tubes for structural purposes
IS-1172	Basic requirements for water supply, drainage and sanitation
IS-1199	Methods of sampling and analysis of concrete
IS-1566	Hard-drawn steel wire fabric for concrete reinforcement
IS-1742	Code of Practice for Building drainage
IS-1785	Plain hard-drawn steel wire for pre-stressed concrete
IS-1786	High strength deformed Steel Bars and wires for concrete reinforcement
IS-1811	Methods of sampling Foundry sands
IS-1893	Criteria for earthquake resistant design of structures
IS-2062	Steel for general structural purposes

IS-2064	Selection, installation and maintenance of sanitary appliances-code of practices
IS-2065	Code of practice for water supply in buildings
IS-2090	High tension steel bars used in pre-stressed concrete
IS-2140	Standard Galvanized steel wire for fencing
IS-2470 (P1 & P2)	Code of practice for installation of septic tanks
IS-2514	Concrete vibrating tables
IS-2645	Integral cement waterproofing compounds
IS-3025 (Part 1 to Part 48)	Methods of sampling and test (Physical and chemical) for water and wastewater
IS-4091	Code of practice for design and construction of foundations for transmission line towers and poles
IS-4111 (Part 1 to P5)	Code of practice for ancillary structures in sewerage system
IS-4990	Plywood for concrete shuttering work
IS-5600	Sewage and drainage pumps
National building code of India 1970	
USBR E12	Earth Manual by United States Department of the interior Bureau of Reclamation
ASTM-A392-81	Zinc/Coated steel chain link fence fabric
ASTM-D1557-80	test for moisture-density relation of soils using 10-lb (4.5 kg) rammer 18-in. (457 mm) Drop
ASTM-D1586(1967)	Penetration Test and Split-Barrel Sampling of Soils
ASTM-D2049-69	Test Method for Relative Density of Cohesionless Soils
ASTM-D2435	Test method for Unconsolidated, (1982) Undrained Strengths of Cohesive Soils in Triaxial Compression
BS-5075	Specification for accelerating Part I Admixtures, Retarding Admixtures and Water Reducing Admixtures
CPWD	Latest CPWD specifications
ACSR MOOSE CONDUCTOR	
IS:6745 BS:443-1969	Methods for Determination of Mass of zinc coating on zinc coated Iron and Steel Articles
IS:8263	Methods for Radio Interference
IEC 437-1973 NEMA:107-1964 CISPR	Test on High Voltage Insulators
IS:209, BS:3436-1961	Zinc Ingot
IS:398 Part - V IEC 209-1966	Aluminum Conductors for Overhead Transmission Purposes
BS:215(Part-II), IEC 209-1966	Aluminium Conductors galvanized steel reinforced extra high voltage (400 kV and above)
IS:1778, BS:1559-1949	Reels and Drums for Bare Conductors
IS:1521, ISO/R89-1959	Method for Tensile Testing of steel wire
IS:2629	Recommended practice for Hot dip Galvanizing on Iron and

	Steel
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles
IS:4826/ASTMA-472-729	Hot dip galvanized coatings on round steel wires
GALVANISED STEEL EARTHWIRE	
IS:1521, ISO/R:89-1959	Method for Tensile Testing of Steel Wire
IS:1778	Reels and Drums for Bare Conductors
IS:2629	Recommended practice for Hot Dip Galvanizing on Iron and Steel
IS:2633	Methods for testing Uniformity of Coating of Zinc Coated Articles
IS:4826/ ASTM: A 475-72a BS:443-1969	Hot dip Galvanized Coatings on Round Steel Wires
IS:6745/ BS:443-1969	Method for Determination of mass of Zinc Coating on Zinc coated Iron and Steel Articles.
IS:209/ BS:3463-1961	Zinc ingot
IS:398 (Pt. I to P5:1992)/ BS:215 (Part-II	Aluminum Conductors for overhead transmission purposes
Lighting Fixtures and Accessories	
IS:1913	General and safety requirements for electric lighting fittings
IS:3528	Waterproof electric lighting fittings
IS:4012	Dust proof electric lighting fittings
IS:4013	Dust tight proof electric lighting fittings
IS:10322	Industrial lighting fittings with metal reflectors
IS:10322	Industrial lighting fittings with plastic reflectors
IS:2206	Well glass lighting fittings for use underground in mines (non-flameproof type)
IS:10322	Specification for flood light
IS:10322	Specification for decorative lighting outfits
IS:10322	Luminaries for street lighting
IS:2418	Tubular fluorescent lamps
IS:9900	High pressure mercury vapour lamps
IS:1258	Specification for Bayonet lamp fluorescent lamp
IS:3323	Bi-pin lamp holder tubular fluorescent lamps
IS:1534	Ballasts for use in fluorescent lighting fittings. (Part-I)
IS:1569	Capacitors for use in fluorescent lighting fittings
IS:2215	Starters for fluorescent lamps
IS:3324	Holders for starters for tubular fluorescent lamps
IS:418	GLS lamps
IS:3553	Watertight electric fittings
IS:2713	Tubular steel poles
IS:280	MS wire for general engg. Purposes

Conduits, Accessories and Junction Boxes	
IS:9537	Rigid steel conduits for electrical wiring
IS:3480	Flexible steel conduits for electrical wiring
IS:2667	Fittings for rigid steel conduits for electrical wiring
IS:3837	Accessories for rigid steel conduits for electrical wiring
IS:4649	Adaptors for flexible steel conduits
IS:5133	Steel and Cast Iron Boxes
IS:2629	Hot dip galvanising of Iron & Steel
Lighting Panels	
IS:13947	LV Switchgear and Control gear(Part 1 to 5)
IS:8828	Circuit breakers for over current protection for house hold and similar installations
IS:5	Ready mix paints
IS:2551	Danger notice plates
IS:2705	Current transformers
IS:9224	HRC Cartridge fuse links for voltage above 650V(Part-2)
IS:5082	Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes
IS:8623	Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC
IS:1248	Direct Acting electrical indicating instruments
Electrical Installation	
IS:1293	3 pin plug
IS:371	Two to three ceiling roses
IS:3854	Switches for domestic and similar purposes
IS:5216	Guide for safety procedures and practices in electrical work
IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
IS:3043	Code of practice for earthing
IS:3646	Code of practice of interior illumination part II & III
IS:1944	Code of practice for lighting of public through fares
IS:5571	Guide for selection of electrical equipment for hazardous areas
IS:800	Code of practice for use of structural steel in general building construction
IS:2633	Methods of Testing uniformity of coating on zinc coated articles
IS:6005	Code of practice for phosphating iron and steel
	INDIAN ELECTRICITY ACT
	INDIAN ELECTRICITY RULES
LT SWITCHGEAR	
IS:8623 (Part-I)	Specification for low voltage switchgear and control gear assemblies

IS:13947 (Part-I)	Specification for low voltage switchgear and control gear, Part 1 General Rules
IS:13947 (part-2)	Specification for low voltage switchgear and control gear, Part 2 circuit breakers
IS:13947 (part-3)	Specification for low voltage switchgear and control gear. Part 3 Switches, Disconnectors, Switch-disconnectors and fuse combination units
IS:13947 (part-4)	Specification for low voltage switchgear and control gear. Part 4 Contactors and motors starters
IS:13947 (part-5)	Specification for low voltage switchgear and control gear. Part 5 Control-circuit devices and switching elements
IS:13947 (part-6)	Specification for low voltage switchgear and control gear. Part 6 Multiple function switching devices
IS:13947 (part-7)	Specification for low voltage switchgear and control gear. Part 7 Ancillary equipments
IS:12063	Degree of protection provided by enclosures
IS:2705	Current Transformers
IS:3156	Voltage Transformers
IS:3231	Electrical relays for power system protection
IS:1248	Electrical indicating instruments
IS:722	AC Electricity meters
IS:5578	Guide for Marking of insulated conductors of apparatus terminals
IS:13703 (part 1)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 1 General Requirements
IS:13703 (part 2)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 2 Fuses for use of authorized persons
IS:6005	Code of practice of phosphating iron and steel
IS:5082	Wrought Aluminum and Aluminum alloys for electrical purposes
IS:2633	Hot dip galvanizing

Note: If any standard is expired or does not exist anymore than other standard which has substituted it, shall be applicable.

ANNEXURE-IV: LIST OF DRAWINGS/DOCUMENTS FOR SECOND ADVANCE**1. ELECTRICAL DRAWINGS/DOCUMENTS FOR SWITCHYARD**

- a. Single Line Diagram
- b. Electrical Layout – Plan and Sections
- c. DSLP Calculation and drawing
- d. Structure Layout (Plan & Section) drawing.
- e. Foundation & Cable Trench Layout
- f. Earth mat Layout
- g. Short circuit Force and Critical Span Calculations (for non-standard span)
- h. Cantilever Strength calculations (for non-standard span)

2. CIVIL DRAWINGS/DOCUMENTS

- a. Soil Investigation Report (if applicable)
- b. Structure Design, Foundation Design & Drawing, Plinth Beam Design & Drawing and column Design & Drawing up to G.F. Level of control room building.
- c. Structure Design, Foundation Design & Drawing, Plinth Beam Design & Drawing and column Design & Drawing of GIS building(s)

3. DRAWINGS/DOCUMENTS OF EQUIPMENT

- a. Circuit Breaker, Isolator, CT, CVT, IVT, Surge Arrestor, Bus Post Insulator
 - Drawing, GTP and Type test Reports
- b. Control and Relay Panels
 - GTP and Type test Reports
- c. Substation Automation System (SAS)
 - GTP and Type test Reports

4. DRAWINGS/DOCUMENTS OF POWER TRANSFORMER

- a. Design Review documents.
- b. GA drawings for transformer, bushings
- c. Foundation Plan
- d. GTP
- e. RTCC -GA and schematic drawings
- f. Rating and Diagram Plate
- g. Power Transformer foundation design & drawings (if Applicable)
- h. For Single Phase Autotransformer (if Applicable)
 - Single Line Diagram
 - Electrical Layout & Section
 - Foundation Layout including Neutral & Delta Formation

5. DRAWINGS/DOCUMENTS OF REACTOR

- a. Design Review documents.

- b. GA drawings for reactor, NGR, LA, bushings
 - c. Foundation Plan
 - d. GTP
 - e. Rating and Diagram Plate
 - f. Shunt Reactor, NGR & SA foundation design & drawings (if Applicable)
 - g. For Single Phase Reactor (if Applicable)
 - Single Line Diagram
 - Electrical Layout & Section
 - Foundation Layout including Neutral Formation
6. DRAWINGS/DOCUMENTS OF GIS
- a. GTP
 - b. Gas Line Diagram
 - c. GIS Layout Drawing
7. DRAWINGS/DOCUMENTS OF EHV Cable (132kV of Above)
- a. GTP
 - b. Cross Section Drawing

NOTES: -

1. The list of drawings/ documents mentioned above is a standard list. Some of the items may not be applicable and need not to be referred to for a particular substation package.
2. In case type tests are to be repeated/conducted, then approval of type test reports is not required at this stage.
3. Category-II approved drawings shall also be considered for release of second/engineering advance.

ANNEXURE-V: COMPREHENSIVE LIST OF DRAWING SUBMISSION SCHEDULE

SL.NO.	DRAWINGS/DOCUMENTS TITLE	CATEGORY
1.00	DRAWING FOR SWITCHYARD	
1.01	Overall General Arrangement Drawing	A
1.02	Single Line Diagram	A
1.03	Electrical layout plan & section	A
1.04	Structure loading diagram cum layout arrangement	A
1.05	DSLPP Calculation & layout	A
1.06	Switchyard Foundation & cable Trench Layout	A
1.07	Indoor Cable Trench Layout (As applicable for Control Room Building, GIS Hall, Switchyard panel Room, FFPH Building)	A
1.08	Buried Cable Trench layout	A
1.09	Erection Key Diagram (plan & section) & Erection Bill of Quantity	A
1.10	Earth mat layout	A
1.11	Indoor Illumination layout (As applicable for Control Room Building, FFPH Building, Transit Camp, Switchyard panel Room, GIS Hall)	A
1.12	Outdoor illumination Layout	A
1.13	SLD of LT AC/DC System	A
1.14	Panel arrangement layout in Control Room Building	A
1.15	Panel arrangement layout in Switchyard panel room/LCR Room of GIS Hall	A
1.16	Fire detection and alarm system for control Room building GIS Building and Switchyard panel room	A
1.17	Air Conditioning Layout (As applicable for Control Room Building, LCR room in GIS Hall, Switchyard panel Room)	
1.18	LT Station Layout	A
1.19	Power and control cable schedule	A
2.00	DESIGN CALCULATION	
2.01	DSLPP calculation	R
2.02	Lighting system design calculation (if applicable)	R
2.03	Earthing system design calculation (if applicable)	R
2.04	Battery sizing calculation (if applicable)	R
2.05	Hydraulic Calculation for Fire protection (if applicable)	R
2.06	AC and ventilation calculation for GIS Building (if applicable)	R
2.07	EOT crane sizing calculation	R
3.00	GAS INSULATED SWITCHGEAR	
3.01	Design Review along with all supporting documents for new design of GIS	A
3.02	Guaranteed Technical Particular (GTP)	A
3.03	Type Test Reports of GIS	A
3.04	Drawings, GTP & Type Test Reports of SF6/Air Bushing	A
3.05	Component Drawing of Each type of GIS Equipment	R
3.06	Single Line Diagram	A

3.07	Layout for GIS Arrangement (Plan and Section View and plate form arrangement)	A
3.08	Foundation for GIS (Including Loading Data)	A
3.09	Earthing Layout including Special Earthing Requirement for GIS	R
3.10	Gas System Diagram	A
3.11	GIS support Structure layout including Details of Support Structure.	A
3.12	GIS Key Diagram	R
3.13	PD Location Layout along with sensitivity attenuation calculation	R
3.14	GA & Schematic drawings of Local Control Cabinets (LCC)	A
3.15	Type Test Reports of Local Control Cabinets (LCC)	A
3.16	Spare Parts List (Based on Contract)	A
3.17	Special Tools List (Based on Contract)	A
3.18	Name Plates	A
3.19	GA, Data Sheet, and Catalogues for	
a)	SF6 gas leakage detector	R
b)	SF6 gas filling & evacuation plant	R
c)	SF6 gas Analyzer	R
d)	Partial discharge monitoring system	R
e)	catalogue of UHF sensors	R
3.20	GA & Schematic drawings of overhead crane	A
4.00	AUTOTRANSFORMER	
4.01	Design Review	R
4.02	Guaranteed Technical Particulars	A
4.03	Outline General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
4.04	Foundation Plan	A
4.05	GA & schematic drawing of Cooler control cabinet/Marshalling Box and Write up	A
4.06	GA & schematic drawing of Common Marshalling Box and Write up (as applicable)	A
4.07	GA & schematic drawing of Drive Mechanism Box and Write up	A
4.08	Bushing dwg and GTP (HV, IV, LV and Neutral as applicable)	A
4.09	Radiator Details	A
4.10	Magnetizing Characteristics of bushings CT	A
4.11	Rating and Diagram plate	A
4.12	Valve Schedule plate rating	A
4.13	Twin-Bidirectional roller	A
4.14	Type Test Report	A
4.15	Instruction Manual	R
5.00	REACTOR	
5.01	Design Review	R
5.02	Guaranteed Technical Particulars	A
5.03	Outline General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
5.04	Foundation Plan	A

5.05	Bushing dwg and GTP (HV and Neutral)	A
5.06	GA & schematic drawing of Marshalling Box and Write up	A
5.07	Magnetization characteristics of Reactor Core and bushing CTs	A
5.08	Rating and diagram plate	A
5.09	Twin bi-directional roller	A
5.10	Radiator Details	A
5.11	Type test Report	A
5.12	Instruction Manual	R
6.0	NEUTRAL GROUNDING REACTOR (NGR)	
A	Air Core NGR	
6.01	Design Review	R
6.02	Guaranteed Technical Particulars	A
6.03	General Arrangement Drawing with pedestal details and Bill of material (OGA parts list) & Shipping details	A
6.04	Foundation Plan	A
6.05	Rating and diagram plate	A
B	Oil Filled Type NGR	
6.06	Design Review	R
6.07	Guaranteed Technical Particulars	A
6.08	General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
6.09	Foundation Plan including Combined Foundation for NGR & LA	A
6.10	Rating and diagram plate	A
7.00	CIRCUIT BREAKER	
7.01	GA drawing of SF6 CB	A
17.02	OGA drawing of control unit	A
7.03	OGA drawing of support insulator, interrupter insulator	R
7.04	Support structure & foundation plan drawing	A
7.05	Electrical schematic diagram	A
7.06	Rating and name plate drawing	A
7.07	Hydraulic/SF6 gas connection diagram	R
7.08	Schematic diagram of operating mechanism	R
7.09	Wiring diagram	R
7.10	Terminal connector and corona rings	R
7.11	Sectional view of interrupter	R
7.12	GTP	A
7.13	Type Test Reports	A
7.14	Instruction Manual	R
8.00	ISOLATOR	
8.01	GA drawing of Isolator without earth switch	A
8.02	Contact blade assembly (main & earth switch)	R
8.03	Terminal pad & hinge contacts	R
8.04	GA of MOM – main switch	R

8.05	Schematic & wiring drg. for main switch	R
8.06	Name plate - details	A
8.07	GA of terminal connectors	A
8.08	GA of post insulator for isolator	R
8.09	GTP	A
8.10	Type Test Report	A
8.11	Instruction Manual	R
9.00	INSTRUMENT TRANSFORMER (CT/CVT/IVT)	
9.01	GTP	A
9.02	General Arrangement	A
9.03	Sectional view	R
9.04	Sec. terminal box GA	R
9.05	GA of Junction box	R
9.06	Data sheet of junction box	A
9.07	Wiring drg of JB incl. interpole	R
9.08	Terminal connectors	A
9.09	Schematic & rating plate	R
9.10	Porcelain insulator	R
9.11	Corona ring	R
9.12	Type Test Reports	A
9.13	Instruction Manual	R
10.00	SURGE ARRESTER	
10.01	GA of Surge Arrester	A
10.02	GTP	A
10.03	Porcelain insulator	R
10.04	Cross sectional view	R
10.05	Arrestor and unit name plate	A
10.06	Grading rings	R
10.07	Insulating base / surge counter detail	R
10.08	Outline drawing of surge counter	R
10.09	Circuit diagram of surge counter	R
10.10	GA of ZnO element	R
10.11	Line terminal bracket with corona rings	R
10.12	Drawing showing pressure relief arrangement.	R
10.13	Type Test Report	A
10.14	Instruction Manual	R
11.00	BUS POST INSULATOR	
11.01	GA drawing & GTP	A
11.02	Type Test Reports	A
12.00	Marshaling Box, Junction Boxes	
12.01	GA Drawings	A
12.02	Schematic Drawing	A

12.03	Type Test reports	A
13.00	Conductor, Al Tube & GS Earth Switch	
13.01	Type Test Reports (if applicable)	A
14.00	DISC INSULATOR (if applicable)	
14.01	GA drawing	A
14.02	Type Test Reports	A
15.00	LONG ROD POLYMER INSULATOR	
15.01	GA drawing	A
15.02	Type Test Reports	A
16.00	INSULATOR STRINGS WITH HARDWARE ASSEMBLY	
16.01	GA DRG	A
16.02	Component drawings	R
16.03	Type Test Reports	A
17.00	CLAMPS & CONNECTORS	
17.01	Drawings	A
17.02	Type Test Reports	A
18.00	HORN GAP FUSE	
18.01	GA OF HG FUSE	A
18.02	Type Test Reports	A
19.00	BATTERY AND BATTERY CHARGER	
19.01	GTP	A
19.02	Drawings	A
19.03	Type Test Reports	A
20.00	ILLUMINATION	
20.01	GTP of all types of fittings/fixtures & control gear	A
20.02	GA drawing of lighting poles/posts	A
20.03	Wiring drawing of panel/LDBs to fixtures	R
20.04	GA of Junction box	A
20.05	GA street lighting panel/outdoor lighting panel	A
20.06	GA of Receptacles	A
21.00	LT SWITCHGEAR	
21.01	GA drawing of ACDB	A
21.02	SLD of ACDB	A
21.03	GA drawing of 220V DCDB	A
21.04	SLD of 220V DCDB	A
21.05	GA drawing of 50V DCDB	A
21.06	SLD of 50V DCDB	A

21.07	Data sheet	A
21.08	Sch. of each type of module	R
21.09	Type Test Reports	A
21.10	Instruction Manual	R
22.00	HT Power Cable	
22.01	GTP & Catalogue	A
22.02	Type Test Reports	A
23.00	POWER & CONTROL CABLE	
23.01	Type Test Reports for Power Cable	A
23.02	Type Test Reports for Control Cable	A
24.00	CONTROL AND RELAY PANELS & SUBSTATION AUTOMATION SYSTEM (SAS)	
24.01	GTP & detailed technical literature & O&M manuals of all types of relays, SAS Equipment	A/R
24.02	Type Test Reports of all relays & equipment	R
	GA and schematic drawing for:	
a)	Relay and protection panels for all type line(s)	A
b)	Relay and protection panels for all type autotransformer(s) including tertiary loading	A
c)	Relay and protection panels for bus/line reactor(s)	A
d)	Relay and protection panels for tie bay(s)	
e)	Relay and protection panels for TBC bay(s)	A
f)	Relay and protection panels for BC bay(s)	A
g)	Busbar protection panel (s)	A
h)	Circuit Breaker relay panel(s)	
24.03	Panel Construction Details	A
24.04	SAS Architecture	A
24.05	Relay Settings	A
25.00	Visual Monitoring System	
25.01	GTP/Catalogue of VMS Equipment and Camera	A
25.02	VMS Architectural Drawing	A
26.00	PLCC EQUIPMENTS	
26.01	GTP & technical literature	A/R
26.02	Type Test Reports of all PLCC equipment	A
26.03	GA & GTPs for wave trap	A
26.04	GA drawing of PLCC terminal	R
26.05	Digital/ Analog Protection coupler	R
26.06	SNR calculation (if applicable)	R
26.07	Coupling device	R
26.08	GTP of HF cable	A
26.09	Testing & maintenance equipment	R

26.10	Frequency Planning	A
27.00	DG SET	
27.01	GTP	A
27.02	Drawings/manuals	A
28.00	AIR CONDITIONING & VENTILATION SYSTEM	
28.01	GTP	A
28.02	Drawings	A
28.03	A/C sizing calculation	A
29.00	LT TRANSFORMER	
29.01	GTP	A
29.02	Drawings	A
29.03	Type Test Reports	A
30.00	FIRE PROTECTION SYSTEM	
30.01	Piping layout in the switchyard	A
30.02	HVW spray system drawings (plan, elevation, side view, isometric view and pylon support details)	R
30.03	Pylon support locations	R
30.04	Schematic and GA for LCP for deluge valve operation	A
30.05	Hydraulic calculations for HVW spray network	R
30.06	Drawing for deluge valve housing	A
30.07	GTP & drawings for strainers (Y type & basket strainer)	A
30.08	Drawing of valve pit details	A
30.09	System writeup with various settings	A
30.10	GTP & drawing for gate valve, check valve, solenoid valve, outdoor hydrant valve	A
30.11	GTP & catalogue for deluge valve, spray nozzles & projectors	A
30.12	GTP & catalogue for quartzoid bulb detector	A
30.13	GTP & drawing for pressure switch, pressure gauge	A
30.14	GTP for G.I. & M.S. pipes & pipe accessories	A
31.00	CONTROL ROOM BUILDING / TRANSIT CAMP /FFPH BUILDING/SWITCHAYRD PANEL ROOM/INDOOR HT SWITCHGEAR ROOM/TOWNSHIP BUILDINGS (AS applicable)	
31.01	Architectural drawing	
a)	Plan, Section & elevation	A
b)	Doors and Window Schedule	A
31.02	Building design calculation (if applicable)	A
31.03	Civil Construction Drawings	A
32.00	DRAWING FOR GIS BUILDING (if Applicable)	A
31.01	Architectural drawing	A
a)	Plan, section & elevation	A

b)	Doors & windows schedule	A
31.02	GIS Building Superstructure drawings & design calculation	A
31.03	Civil Construction Drawings	A
31.04	GIS Equipment foundation inside GIS building	A
33.0	SWITCHYARD CIVIL CONSTRUCTION DRAWING (AS APPLICABLE)	
33.01	Tower Foundation	A
33.02	Equipment Foundation	A
33.03	Transformer Foundation	A
33.04	Reactor Foundation	A
33.05	Road Construction including culverts, rail cum roads	A
33.06	Switchyard fencing and Gate	A
33.07	Cable trench section	A
33.08	Drain Section	A
33.09	Rain water harvesting	A
33.10	Boundary wall	A
33.11	DG Set foundation	A
33.12	LT transformer foundation	A
33.13	Car parking Shed/Security Room	A
33.14	Out Door GIB foundations	A
33.15	Outdoor Sf6/Air Bushing Foundation	A
33.16	BMK/Lighting pole foundation	A
33.17	Fire wall	A
33.18	Contour layout	A
33.19	Drawing of formation level	A
33.20	Soil investigation Report	A
33.21	Any other foundation in Switchyard	A
34.00	DESIGN, FABRICATION & PROTO CORRECTED DRAWINGS OF ALL TYPES OF TOWERS & BEAMS	R
35.00	DESIGN, FABRICATION DRAWINGS FOR EQUIPMENT SUPPORT STRUCTURES	R
36.00	MISCELLANEOUS CIVIL DRGS	A

LEGEND: - A- for Approval; R:- for Record

Note: i) The above list of Drawing is indicative. The same shall be used for formulation of Master Drawing List (MDL).

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

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

ANNEXURE-VII: INSPECTION LEVEL REQUIREMENT

Class	Items
Level-I	Reactors / Transformers
	GIS modules
	Circuit Breaker
	Current Transformer
	Capacitive Voltage Transformer
	Wave Traps
	Control & relay panel
	Substation Automation System
	PLCC & FOTE Equipment
	Surge Arrestor
	Isolator / Disconnecter
	Post, Long rod & Disc Insulator
	LT Power, Control Cables & Instrumentation Cables
	LT Switchgear
	Structures
	NCT/NGR
Level-II	PEB Structures
	EOT Cranes
	Clamps, Connector, Spacers, Welding sleeves
	Lighting Panels
	Lighting Poles
	Conductor
	Al Tube
	Fire Protection, Firefighting material (Pump, Panels, NIFPS)
	Earthing Material (MS/ GS Flats, Electrodes, Earth wires, cleats)
	Fasteners & Foundation Bolts
	HG Fuse
	JB, BMK, Receptacles
	Battery Chargers and Battery Banks
Level-III	Fire Protection, Firefighting material (Pipe, fire extinguisher, QBD, Nozzle, Hose box/pipe, branch pipe, level indicator/switch, pressure gauge, pressure switch, Strainer, Valves, Air vessel)
	Cable Trays
	Cable Lugs, Glands & termination kit
	Erection Hardware
	MS Rods
	PVC Pipe
	Pipe fittings, HF cable, FO Cable, conduits, Spares, Light Fittings, Illumination system, Air Conditioning system, Ventilation system, HVAC system, Fans, switchboard, wires, socket, occupancy sensor, all equipment accessories

Note: Employer reserves the right to change the inspection category of any material during the Project. Inspection category of any items required in the Project and not explicitly mentioned in the above list shall be decided by the Employer and communicated to the Contractor.

ANNEXURE-VIII: RTV Silicone high voltage insulation coating (HVIC)

1. SCOPE

The scope of work shall include supply, transportation and application of RTV-1 silicone rubber high voltage insulator coating and cleaning/removal of waste from the equipment.

- a) All the required materials, tools & tackles, testing equipment including man lift etc. are in the scope of successful bidders/contractor.
- b) Surface preparation:
All equipment surfaces to be coated should be made free from dust, grease, oil etc. & other foreign matter. Also, the surface meant for application must be dry.
- c) The RTV coating supplied for application should be properly mixed before application as per the recommendations of manufacturer. The coating should cover complete surface and should be applied in manner that prevents runs, sags, drips, spills etc. The application shall be done by certified applicator of Manufacturer.
- d) Successful bidder/contractor shall submit the detailed field quality plan for approval. It is not the intention of this specification to specify completely herein all details and design requirements. However, the materials offered & work execution shall confirm in all respects to high standards of engineering and workmanship and be capable of performing in continuous commercial operation up to guarantee in a manner acceptable to purchaser.

2. CLIMATIC CONDITIONS:

The overall climate is moderate hot, humid, tropical, highly polluted and conducive to rust and fungus growth. The climatic conditions are prone to wide range of outdoor service conditions.

3. APPLICABLE CODES AND STANDARDS

The latest revision/amendments of the following Codes and Standards shall be applicable for the equipment/material covered in this Technical Specification. In case of conflict, the vendor/manufacturer may propose equipment/material conforming to one group of Industry Codes and Standards quoted hereunder without jeopardizing the requirements of the technical specification.

IEC 60243-1	Electric strength of insulating materials - Test methods - Part 1: Tests at power frequencies
IEC TR 62039	Selection guide for polymeric materials for outdoor use under HV stress
IEC 60250	Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical materials at power, audio and radio frequencies including meter wavelengths
IEC 60587	Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion
IEC TS 62073	Guidance on the measurement of hydrophobicity of insulator surfaces
IEC 61621	Dry, solid insulating materials-Resistance test to high - voltage, low - current arc discharges
IEC 62217	Polymeric HV insulators for indoor and outdoor use-General definitions, test methods and acceptance criteria

IEC 62631-3-2	Dielectric and resistive properties of solid insulating materials - Part 3-2: Determination of resistive properties (DC methods) - Surface resistance and surface resistivity
IEEE Std 957	IEEE Guide for Cleaning Insulators
IEEE Std 1523	IEEE Guide for the Application, Maintenance and Evaluation of Room Temperature Vulcanizing (RTV) Silicone Rubber Coatings for Outdoor Insulation Applications.
ASTM D149-09	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D150-11	Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
ASTM D257-14	Standard Test Methods for DC Resistance or Conductance of Insulating Materials
ASTM D495-14	Standard Test Method for High - Voltage, Low - Current, Dry Arc Resistance of Solid Electrical Insulation
CEA LWIWG-02 (1996)	Line Post Composite Insulator for Overhead Distribution Lines

4. Technical Parameters:

4.1 RTV Silicon compound in its liquid form shall have the following properties:

Material Properties	Requirement
Material Type	One-part RTV
Appearance	Paint
Filler type	ATH, Quartz, or both
Color	Gray
Percent of solids by weight	≥ 70%
Substrate Application Temperature Range °C	-4°C to 121°C
Tack free at 25°C and 50% RH	30 minutes

4.2 RTV Silicon coating after cured form shall have the following properties:

Parameters	Requirement
Application Area	Glass, Porcelain, station insulators, as well as bushing, instrument transformers and related devices
Full cure time	≥ 24 hours
Coating thickness	500 microns + 10% tolerances, dry film thickness
Dielectric Strength	≥ 20 kV/mm
Volume Resistivity	≥ 1.0*10 ¹² ohm-m
Tracking and Erosion test	1000 Hours
Min. Salinity Level withstood during “Artificial Pollution Test using Salt Fog Method”	≥160 kg/m ³
Hydrophobic Recovery Test	HC2 or HC1
Method of Application	Airless Spray
Dry Arc resistance	Tract ≥ 140 seconds Burn Out ≥ 420 seconds

Tracking and Erosion (IEC 60587, Method 1: Application of constant tracking voltage)	Class 1A 4.5kV or better
Primer Required	No primer material shall be allowed
Resistant to	Marine salt fog, Water, Industrial (cement dust, fly ash, acid emission etc.), Rough Weather Conditions
Other Properties	Non-Hazardous to environment, surface after full cure shall be smooth

4.3 Materials

- i. The RTV Silicone high voltage insulation coating shall be ultraviolet (UV) radiation exposure resistant. The finished product shall withstand the adverse atmospheric conditions due to weather, proximity to the coast, fumes, ozone, acids (particularly nitric acid in the coastal areas and sulphuric acid in the oil field areas), bases/alkalis, and hydrocarbon components, dust or rapid changes to air temperature (temperature extremes). There shall not be significant material degradation such as development of surface cracks and unacceptable increase in surface hardness etc.
- ii. The RTV Silicone high voltage insulation coating shall be resistant to atmospheric and chemical degradation. Salt air, airborne pollutants, industrial pollutants such as cement dust, sulphur, rain and humidity shall not result in flashover on the coating.
- iii. The RTV Silicone high voltage insulation coating shall be resistant to arcing and corona. The Coating shall exhibit high tracking resistance to reduce damage during salt-storms (storms arising from the sea) or other severe contamination events. The track resistance of the RTV Silicone Rubber Insulator Coating material shall meet the requirements of IEC 60587, Method 1, Class 1A 4.5kV.
- iv. The RTV Silicone high voltage insulation coating shall be a single component, ready-to-use after simple mixing. It shall not require excessive mixing/shaking and thinning/dilution before use. The Coating shall be moisture curable at room temperature.
- v. The RTV Silicone high voltage insulation coating shall exhibit long-term water repellency and hydrophobicity.
- vi. The RTV Silicone high voltage insulation coating shall not require use of any primer on the ceramic insulators for adhesion purposes.
- vii. The RTV Silicone high voltage insulation coating shall be easy to be reapplied. The Coating shall have excellent arc resistance, excellent unprimed adhesion, easy to apply and spray-able as well as paint-able.
- viii. The RTV Silicone high voltage insulation coating shall have a minimum of 12 month shelf life, which shall effect from the date of manufacturing. The manufacturer shall submit the warranty to this effect. The expiry date shall be marked on the containers. The remaining shelf life of the material shall be at least six (6) months when delivered to site. The coating shall be supplied in cans weighing not more than 25kg.

4.4 Composition and Properties

- i. The RTV Silicone high voltage insulation coating shall be capable of withstanding high-

pressure waterpower washing. To prove this property, a power wash test shall be performed per requirements stated hereafter in this standard.

- ii. The RTV Silicone high voltage insulation coating shall protect the ceramic insulators (porcelain and glass) against flashovers caused by pollution.
- iii. The manufacturer shall advise/recommend suitable method of application and submit written application instructions and shall suggest suitable equipment set-up (size of pump and compressors, etc.) and the compatibility of his product to be reapplied on the RTV coating from other manufacturers.
- iv. The warranty for RTV coating on the equipment shall be for a period of 5 years

4.5 Markings

The packing and expiry dates of coating shall be labelled on the coating cans. The expiry date shall be considered from the packaging date and not from the date of shipment of the coating.

The cans shall be marked for “flammable” or “non-flammable” depending upon the type of solvent used for the dispersion of the coating.

5. TESTS

All test results shall be provided for review and acceptance by customer.

5.1 Type Tests

Type tests as prescribed in relevant standards shall be performed on RTV coated sample tiles or RTV coated insulators as applicable to verify the suitability of the design, materials and method of manufacture. Testing shall include, but not limited to following. These tests shall be performed only on the new design of RTV silicone high voltage insulation coating. The test reports shall be submitted from tests done in a NABL/International accredited lab.

- a. Tracking and erosion resistance test (IEC 60587, Method 1, Class 1A 4.5kV). Samples shall consist of smooth porcelain plates of 6mm (\pm 0.5mm) thickness coated with the thickness of the material as proposed by the manufacturer for the offered coating. Breaking of porcelain substrate shall not be allowed.
- b. Salt-fog tests
The 1000-hour Tracking and erosion test outlined in IEC-62217 shall be carried out.
- c. Dry arc resistance test
Dry arc resistance test shall be carried out as per ASTM D495.
- d. Contact Angle Measurement Test:
Receding contact angle measurement test shall be performed in accordance with IEC TS 62073.
- e. BDV testing of fully cured coating.
The test shall be carried out as per IEC:60243-1 or ASTM D149.
- f. Volume Resistivity Test

The test shall be carried out as per IEC:60093. Sample thickness shall be 2mm which can be obtained by using an open mould casting technique. The minimum volume resistivity as specified shall be achieved.

- g. Artificial Pollution Test in general with IEC 60507 without the pre-condition test.
- h. Adhesion Test as type test:
Adhesion test shall be performed in accordance with Canadian Electric Association (CEA) specification LWIWG-02 (96) or any other equivalent standard to verify the bonding characteristics of the RTV Silicone Rubber Coating when applied to ceramic insulators. Three (3) coated insulators shall be put in water having 0.1% by weight of NaCl and boiled for 100 hours (each sample separately). At the end of boiling, allow each insulator to remain in the water until the water cools to about 50°C. The coating shall not exhibit any water blisters at the interface between the insulator surface and the coating.

5.2 Acceptance Tests (at Site or Factory)

- a. Thickness measurement:

Dry film thickness (DFT) of the coating shall be measured at site on all Equipments randomly at least at one point of the Equipment.

- b. Adhesion Test as acceptance test:
Adhesion test shall be performed at site in accordance with CEA specification LWIWG-02 (96) or any other equivalent standard to verify the bonding characteristics of the RTV Silicone Rubber Coating when applied to ceramic insulators. Three (3) coated insulators shall be put in water having 0.1% by weight of NaCl and boiled for 2 hours (each sample separately). At the end of boiling, allow each insulator to remain in the water until the water cools to about 50°C. The coating shall not exhibit any water blisters at the interface between the insulator surface and the coating.
- c. High Pressure Water Withstand Test:
A power water wash test shall be performed at site on 5% sample in accordance with IEEE Std 957 to demonstrate that the RTV coated insulators can be power washed without any damage to RTV coating. The test shall be a water spray of a solid stream through a 6mm diameter nozzle at 3800 kPa for a period of 10 (ten) minutes. The nozzle of the spray equipment shall be at a distance of 3m from the insulator surface. There should not be any damage to the coating.
- d. Hydrophobicity test:
Hydrophobicity test shall be carried out on virgin material at site on 5% sample on 1-2 coated equipment as per STRI guidelines and the results shall be HC2 class or better. Hydrophobicity test shall be carried out after completion of high-pressure water withstand test.

ANNEXURE-IX: LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
A.	<i>Substation Accessories [Type Testing is not envisaged]</i>	
1.	Outdoor receptacles	CGL/B&C/BCH/Sakti, Chennai/Indo Asian/AVAIDS
2.	Trefoil clamp	Moulded Fibre Glass Products, Calcutta
3.	Diesel Engine	Cummins/Ruston & Hornsby/Greaves Cotton/Kirloskar/Mahindra/Ashok Leyland
4.	Alternator	AVK/KIRLOSKAR/STAMFORD/ Leroy Somer
5.	Motors	KEC/Siemens/NGEF/Crompton/ABB
6.	Cable Glands	Sunil & Co./Arup/ Comet/QPIE
7.	Junction Box	Sarvana/ECS/C&S/Vikas/ Maktel/Unilac/Jasper/ Amara raja/AVAIDS
8.	EPAX	MATRIX, BPL
9.	ACSR Conductor (Bersimis/Moose/Zebra)	Sterlite/Apar/HVPL/Sharavathy/Hiren Aluminium Ltd./Smita/Deepak Cables/Polycab wires/Cabcon/JSK
10.	AAC Conductor (BULL)	Sterlite/Cabcon /JSK
11.	G.S. Earthwire	Sharavathy/Bharat Wire Ropes/Ramswarup
12.	Lighting Fixtures	Phillips/CGL/Bajaj /Havels
13.	Lighting Transformer	Gujarat-Plug-In
14.	Lighting Panels	Vikas/Makel/Nitya/AVAIDS
15.	MCCB/ACB/Protective relays of LT Switchgear Boards	All approved makes as per Compendium of Vendors
16.	EOT Crane	Reva
B.	<i>ACCESSORIES FOR TRANSFORMER & REACTOR [Earlier approved type test reports is applicable and not required to be submitted]</i>	
17.	BUCHHOLZ RELAY [Upto 765kV Transformer & Reactor]	(i) M/S CEDESPE, ITALY [Model Type-EE 3 (Plug & Socket type)]/ (ii) M/s VIAT INSTRUMENTS PVT. LTD.KOLKATA [Model type-GOR-3M (Plug & Socket type)]
18.	PRESSURE RELIEF DEVICE [Upto 765kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG, Pune [Model type-T-6- MS- 15-SHB-PS (Plug & Socket type)] /
19.	MAGNETIC OIL LEVEL GAUGE [Upto 765kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG PUNE [Model type-SO- HE-10-M-ATMS-PS (Plug & Socket type)], [Model Type:- SO-6-M-P-PS (Plug & Socket type)]/

20.	AIR CELL (FLEXIBLE AIR SEPARATOR) [Upto 765kV Transformer & Reactor]	Type test of following makes are not to be submitted. (i) M/S PRONAL FRANCE / (ii) FUJIKURA, JAPAN / (iii) PRONAL ASIA, MALAYSIYA / (iv) SHENYANG HONGDA GENERAL RUBBER FACTORY / (v) BAODING XINKE RUBBER PRODUCT INSTITUTE, CHINA / (vi) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE/ (vii) M/S UNIRUB TECHNO PUNE
21.	OTI & WTI [Upto 765kV Transformer & Reactor]	(i) M/S PRESIMEASURE BANGALORE [Model type-1005A]
22.	OIL PUMP [Upto 765kV Transformer & Reactor]	(i) FLOWWELL PUMPS & METERS, BANGALORE [Model type-1220D, 1250D]
23.	COOLING FAN AND MOTOR ASSEMBLY [Upto 765kV Transformer & Reactor]	(i) M/S MARATHON LTD KOLKATA [Model Type: - 36M/K75-P8, 0.7kW, 725RPM, 22J/K37-P6, 0.25kW, 940RPM, AFF 915103, 0.625kW, 550RPM]
24.	Sudden Pressure Relay [Upto 765kV Transformer & Reactor]	(i) Qualitrol [Model/Drawing No.900-003-02 CS- 46518, 900-003-32 CS-46369] / (ii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No. SYJ9-50-25TH]
25.	BUCHHOLZ RELAY [Upto 400kV Transformer & Reactor]	(i) M/S CEDASPE, ITALY [Model type-EE3 (Plug & Socket type)]/ (ii) VIAT INSTRUMENTS [Model type-GOR-3M (Plug & Socket type)]
26.	PRESSURE RELIEF DEVICE [Upto 400kV Transformer & Reactor]	(i) M/S SKURUT UDYOG, PUNE [Model type-T-6-MS-15-SHB-PS (Plug & Socket type)]
27.	MAGNETIC OIL LEVEL GAUGE [Upto 400kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG PUNE [Model type-SO-HE-10-M-ATMS-PS (Plug & Socket type)], [Model Type: SO-6-M-P-PS (Plug & Socket type)]/ (ii) M/S YOGYA ENTERPRISES, JHANSI [Model type-SO-10 (Plug & Socket type)]
28.	AIR CELL (FLEXIBLE AIR SEPARATOR) [Upto 400kV Transformer & Reactor]	Type test of following makes are not to be submitted. (i) M/S THE RUBBER PRODUCTS MUMBAI / (ii) M/S UNIRUB TECHNO PUNE / (iii) M/S PRONAL FRANCE/ (iv) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE / (v) SHENYANG HONGDA GENERAL RUBBER FACTORY, CHINA

29.	Sudden Pressure Relay [Upto 400kV Transformer & Reactor]	(i) Qualitrol [Model/Drawing No.900-003-02 CS- 46518, 900-003-32 CS-46369] / (ii) VIAT INSTRUMENTS [Model/Drawing No.950 / (iii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No. SYJ9-50-25TH]
30.	RIP Bushing (52kV, 3150A)	ABB Micafil, Switzerland [Model/Drawing No. 1ZCD073617 (Rev F)]
31.	RIP Bushing (420kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005378A0001REV. K]
32.	RIP Bushing (245kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005416A0001 (Rev. D)]
33.	RIP Bushing (245kV, 2000A)	ABB, SWEDEN [Model/Drawing No.1ZSC005373A0001 (Rev. C)]
34.	RIP Bushing (420kV, 1250A)	HSP Germany [Model/Drawing No.327470]
35.	RIP Bushing (245kV, 2000A)	HSP Germany [Model/Drawing No.329260]
36.	RIP Bushing (52kV, 3150A)	HSP Germany [Model/Drawing No.329280]
37.	RIP Bushing (420kV, 1250A)	Izolyator, Russia [Model/Drawing No.686354.603]
38.	RIP Bushing (245kV, 2000A)	Izolyator, Russia [Model/Drawing No.686353.602]
39.	RIP Bushing (52kV, 3150A)	Izolyator, Russia [Model/Drawing No.686351.601]
40.	RIP Bushing (145kV, 1250A)	Izolyator, Russia [Model/Drawing No.686352.604]
41.	RIP Bushing (420kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 707 (C2)]
42.	RIP Bushing (245kV, 2000A)	TRENCH, CHINA [Model/Drawing No. ECT 617 (C3)]
43.	RIP Bushing (245kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 616 (C3)]
44.	RIP Bushing (145kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 516 (C3)]
45.	RIP Bushing (52kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 415 (C3)]
46.	RIP Bushing (52kV, 3150A)	TRENCH, CHINA [Model/Drawing No. ECT 419 (C3)]
47.	RIP Bushing (420kV, 1250A)	Xian China [Model/Drawing No.75706 (Rev 09)]
48.	RIP Bushing (245kV,2000A)	Xian China [Model/Drawing No.75618 (Rev 09)]
49.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No.75366 (Rev 03)]
50.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No.75332 (Rev 08)]
51.	OIP Bushing (800kV, 2500A)	ABB, SWEDEN [Model / Drawing No. GOE-2550-1600- 2500-0.6-B, 1ZSC026186-AAM REV. H]
52.	OIP Bushing (420kV, 2500A)	ABB, SWEDEN [Model / Drawing No.GOE-1425-1150-2500-0.6, 1ZSC026186-AAL REV. F]
53.	OIP Bushing (800kV, 2500A)	TBEA, CHINA [Model / Drawing No. TBEA-500-765T- A0035-01, REV. 02]
54.	OIP Bushing (420kV, 2500A)	TBEA, CHINA [Model / Drawing No. TBEA-500-765T- A0035-02, REV. 02]

55.	OIP Bushing (420kV, 2500A)	TRENCH, CHINA [Model / Drawing No. OT-738-1 (C 5)]
56.	OLTC (500MVA, 765kV ICT)	MR Germany [Model/Drawing No. MI 1503 72.5/RC- 12231WR]
57.	OLTC (500MVA, 400kV ICT)	Easun MR, Chennai [Model/Drawing No. 3 x MI 1200 300/D 10.19.3W]
58.	OLTC (220kV & below rating transformer)	BHEL, Bhopal [Model/Drawing No. MIII 600 110/C 10.19.3W]
C.	TESTING EQUIPMENT FOR TRANSFORMER & REACTOR	
59.	Oil BDV Test Kit	Baur [Model/Drawing No. DTA 100C]
60.	Oil BDV Test Kit	Megger [Model/Drawing No. OTS 100AF]
61.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	A Eberle GmbH & Co. KG [Model/Drawing No. HYDROCAL 1008]
62.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Ningbo Ligong Online Monitoring Technology Co. LTD [Model/Drawing No.MGA2000]
63.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	GE Energy [Model/Drawing No.KELMAN TRANSFIX]
64.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Qualitrol Company LLC [Model/Drawing No. SERVERON TM 8]
65.	On line Insulating Oil Drying System	CEE DEE Vacuum Equipment Pvt. Ltd. [Model/Drawing No. TRANSDRY CD-002]
66.	On line Insulating Oil Drying System	PTSS [Model/Drawing No. PTSS-TDS1GA6XS]
67.	Portable Dissolved Gas Analysis of Insulating Oil	GE Energy [Model/Drawing No. KELMAN TRANSPORT X]

NOTES:

1. For sub-station accessories mentioned at Sr. No. A above, model specific separate approval of type test report is not required.
2. For Transformer/Reactor accessories & testing equipment mentioned at Sr. No. B & C above, wherever, model/drawing no. is specified separate approval of type test report and drawing/documents is not required, thus requirement of type test report validity of 10 years is not applicable.

ANNEXURE-X: List of Equipment's to be supplied from domestic manufacturer only.

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