

End Customer Requirements (technical , Civil , Supply , I&C) - to be complied



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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Contents

1.0 FOREWORD	2
2.0 GENERAL REQUIREMENT.....	2
3.0 STANDARDS.....	3
4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED	3
5.0 ENGINEERING DATA AND DRAWINGS.....	7
6.0 MATERIAL/ WORKMANSHIP	9
7.0 DESIGN IMPROVEMENTS / COORDINATION	12
8.0 QUALITY ASSURANCE PROGRAMME.....	12
9.0 TYPE TESTING & CLEARANCE CERTIFICATE.....	18
10.0 TESTS.....	20
11.0 PACKAGING & PROTECTION	21
12.0 FINISHING OF METAL SURFACES	21
12.3 PAINTING.....	22
13.0 HANDLING, STORING AND INSTALLATION	23
14.0 TOOLS.....	25
15.0 AUXILIARY SUPPLY	26
16.0 SUPPORT STRUCTURE.....	26
17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS.....	26
18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES.....	28
FOR OUTDOOR EQUIPMENT.....	28
19.0 DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE	29
20.0 TERMINAL BLOCKS AND WIRING	29
21.0 LAMPS & SOCKETS.....	30
22.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:.....	31
23.0 MOTORS	32
24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS	34

Annexure-A : Corona and Radio Interface Voltage (RIV) Test

Annexure-B: Seismic Withstand Test Procedure

Annexure-C: List of General Standards and codes

Annexure-D: List of General Standard/Document for second advance

Annexure-E: Comprehensive List of Drawings

Annexure-F: Assessment report from Main Contractor for proposed sub vendor's-List of
Enclosure

Annexure-G: MQP & Inspection Level Requirement

Annexure-H: Specification of RTV coating on porcelain insulators

Annexure-I: Standard Drawing for open platform

Annexure-J: List of make for which type test reports are not required to be submitted

Annexure-K: List of Equipment's to be supplied from domestic manufacturer only

Annexure-L: Major Changes in GTR rev 15

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

1.0 FOREWORD

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

2.0 GENERAL REQUIREMENT

2.1 a) All equipment/materials/items, as per Annexure-K, as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only

Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.

The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract

2.1 b) The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to 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 equipments, project management, training of Employer's manpower, loading, unloading, handling, insurance, moving to final destination for successful erection, testing and commissioning of the substation /switchyard.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 2.6 The Contractor shall be responsible for safety of human 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.

3.0 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 standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification at Annex-C 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 an 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 compliment each other.
- 3.4 When the specific requirements stipulated in the specifications exceed or differ than 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-C/ individual sections for various equipments 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-C/individual sections for various equipments shall be subject to Employer's approval.

4.0 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 the 400kV system, the initial value of the temporary overvoltages could be 2.0 p.u. 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 over voltage conditions.
- 4.2 All equipments 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 taking into account various forces as mentioned at Sl.No.4.3 that are required to withstand.
- 4.5 The equipment shall also comply to the following:
- a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - b) 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.
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

4.6

System Parameter

765kV, 400kV & 220kV System

SL 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	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	2100kVp	1550kVp	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1550kVp	1050kVp	-
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	508 kV	320kV	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	2500 μ V at 508 kV rms	1000 μ V at 266kV rms	1000 μ V at 156kV rms
8.	Minimum creepage distance - for Equipment other than Insulator string	20000 mm (24800 mm for coastal area)	10500 mm (13020 mm for coastal area)	6125 mm (7595 mm for coastal area)
	Minimum creepage	As specified in Section-Switchyard Erection		

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

	distance - for Insulator String			
9.	Min. clearances			
i.	Phase to phase	7600mm (for conductorconductor configuration) 9400mm (for rod-conductor configuration)	4000mm (for conductorconductor configuration) 4200mm (for rod - conductor configuration)	2100 mm
SL No	Description of parameters	765kV System	400kV System	220kV System
ii.	Phase to earth	4900mm (for conductor-structure) 6400mm (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	40kA/50kA (as applicable)	40kA/50kA/ 63 kA (as applicable)	40kA/ 50kA(as applicable)
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

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

SL No	Description of parameters	132 kV System	66kV 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	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3	3
5.	Rated Insulation Levels					

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	250 kVp	170 kVp	75 kVp
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	3625 mm (4495mm for coastal area)	1813 mm (2248mm for coastal area)	1300mm (1612 mm for coastal area)	900 mm (1116mm for coastal area)	300 mm (372mm for coastal area)
SL No	Description of parameters	132 kV System	66kV System	52 kV System	33 kV System	11kV System
8.	Min. Clearance					
i.	Phase to phase	1300 mm	750 mm	530mm	320 mm	280 mm
ii.	Phase to earth	1300 mm	630 mm	480mm	320 mm	140 mm
iii.	Sectional clearances	4000 mm	3100 mm	3100mm	2800 mm	2800 mm
9.	Rated short circuit current	40kA/ 31.5 kA (as applicable) for 1 sec	31.5 kA for 3 sec/25kA for 3 Sec*	25kA for 1 Sec	25 kA for 3 sec	25 kA for 3 sec
10.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Notes:

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

1. 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.
2. The insulation and RIV levels of the equipments shall be as per values given in the Technical Specification of respective equipment.
3. Corona and radio interference voltage test and seismic withstand test procedures for equipments shall be in line with the procedure given at **Annexure-A** and **Annexure-B** respectively.
4. “*” For tertiary loading Equipment’s fault level shall be 25kA for 3 Sec. For other switchyard equipment shall be as specified in Section project.
5. Costal Area is to be considered only if defined in Section project.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Employer is enclosed in **Annexure-E**. 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 online Document Review and Engineering Approval Management System (Herein after DREAMS) for the approval of the employer

5.3 Drawings

5.3.1 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.

5.3.2 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. ENDCUSTOMER has standardized a large number of 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 alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per 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.

5.3.3 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.

5.5 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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.

5.6 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.

5.7 Approval Procedure

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

- i) Approval/comments/ As per L2 schedule by Employer on initial submission
- ii) Resubmission Within 3 (three) weeks (whenever from date of comments required)
- iii) Approval or comments Within 3 (three) weeks of receipt of resubmission.
- iv) Furnishing of distribution 2 weeks from the date
copies (2 hard copies to each of approval substation and one scanned copy (pdf format)
- v) Furnishing of distribution copies of test reports
 - (a) Type test reports 2 weeks from the date of final approval
(one scanned softcopy in pdf format to each substation plus one for corporate centre & one hardcopy per substation)
 - (b) Routine Test Reports -do-
(one copy for each substation)
- vi) Furnishing of instruction/ On completion of Engineering operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)
- (vii) As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- (2) All drawings should be submitted in “DREAMS” Portal, further substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version as a supporting document in DREAMS. 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 as supporting document in DREAMS.

- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (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 furnish to the Employer catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

5.8 The list of major drawings/documents to be approved to qualify for second advance as per Section SCC, shall be as per **Annexure-D**.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 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.

6.1.2 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.

6.1.3 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.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

- 6.1.5 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.
- 6.1.6 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.
- 6.1.7 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. Onoff switch and fuse shall be provided.

6.2.1.2 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.

6.2.2 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.

6.2.3 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.

6.2.4 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 out door: 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 IS/IEC60947; IS/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

6.3.1 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.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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 CONSUMABLES, 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.

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

7.4 The Contractor has to 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 ENDCUSTOMER Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 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 programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following:

- a) The organisation structure for the management and implementation of the proposed quality assurance programme.
- b) System for Document and Data Control.
- c) Qualification and Experience data of Bidder's key personnel.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- d) The procedure for purchases of materials, parts, components and selection of subContractor'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 also 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 authorising 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 out 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 equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised 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:

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- iv) Raw Material test reports on components as specified by the specification and in the quality plan.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- v) The Manufacturing Quality Plan(MQP) indicating 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.
- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE

8.3.1

Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on ENDCUSTOMER web-site www.powergridindia.com after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from ENDCUSTOMER approved existing vendors. In case of their unavailability / non-response, Contractor may approach ENDCUSTOMER for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per **Annexure-F** shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by ENDCUSTOMER, if required, shall be on chargeable basis. Charges shall be as per the ENDCUSTOMER norms prevailing at that time, which shall be intimated by ENDCUSTOMER separately. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, ENDCUSTOMER 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-G** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & ENDCUSTOMER 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 ENDCUSTOMER, MQP shall be generally submitted as per ENDCUSTOMER format before placing order.

Items not covered under MQP/ITP/FAT shall be offered for inspection as per ENDCUSTOMER LOA/technical Specifications/ENDCUSTOMER approved data sheets/ ENDCUSTOMER 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 ENDCUSTOMER or its authorized representative, involvement of ENDCUSTOMER for inspection of various items / equipment will be based on the level below:

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- Level –I:** Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ ENDCUSTOMER specification, and submit to concerned ENDCUSTOMER inspection office/Inspection Engineer. CIP/MICC will be issued by ENDCUSTOMER based on review of test reports/certificates of manufacturers.
- Level – II:** Contractor to raise all inspection calls and carry out the inspection on behalf of ENDCUSTOMER on the proposed date of inspection as per applicable standards/specification. However, in case ENDCUSTOMER wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by ENDCUSTOMER. Else, Contractor would submit their test reports/certificates to ENDCUSTOMER. CIP/MICC will be issued by ENDCUSTOMER based on review of test reports/ certificates.
- Level - III:** Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections (if applicable) on behalf of ENDCUSTOMER on the proposed date of inspection as per applicable standards/specification. However, in case ENDCUSTOMER wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by ENDCUSTOMER. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by ENDCUSTOMER based on review of test reports / certificates. Final inspection will be carried out by ENDCUSTOMER and CIP/MICC will be issued by ENDCUSTOMER.
- Level – IV:** Contractor to raise inspection calls for both, stage (as applicable) & final inspections. ENDCUSTOMER will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by ENDCUSTOMER.

8.3.2 Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).

8.3.3 The Employer, his duly authorised 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 authorised 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 ENDCUSTOMER

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.

- 8.3.4 Contractor shall submit inspection calls over internet through ENDCUSTOMER website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor within 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.
- 8.3.5 The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.
- 8.3.6 Contractor shall generally offer material for inspection as per supply bar chart approved by ENDCUSTOMER and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of ENDCUSTOMER, ENDCUSTOMER shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.
- 8.3.7 Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.
- 8.3.8 Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for ENDCUSTOMER inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.
- 8.3.9 Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for ENDCUSTOMER inspection or specific approval of ENDCUSTOMER QA&I shall be obtained for delayed dispatch.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 8.3.10 The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.
- 8.3.11 All Test Reports and documents to be submitted in English during final inspection of equipment by ENDCUSTOMER or as and when required for submission.
- 8.3.12 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacture 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 ENDCUSTOMER 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.
- 8.3.13 In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised 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 authorised representative to accomplish testing.
- 8.3.14 The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.
- 8.3.15 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
- 8.3.16 The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.
- 8.3.17 Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to ENDCUSTOMER for approval, before taking up the Re-Work/Re-Engineering, failing which ENDCUSTOMER reserves the right to reject the equipment.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 8.3.18 Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from ENDCUSTOMER 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 ENDCUSTOMER approved Third Party Laboratories.
- 8.3.19 Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.
- 8.3.20 Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per ENDCUSTOMER approved guidelines/Technical specifications.
- 8.3.21 Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.
- 8.3.22 For EHV transformers/reactors:**
- Insulation oil shall be as per ENDCUSTOMER 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 airconditioned environment. Core-coil assembly shall be performed in positive pressurized dust controlled environment. Dust measurements shall be monitored regularly at Transformer / Reactor Manufacturer works. Contractor shall ensure that respective civil foundations & Fire walls for Transformer/Reactors units to be commissioned, shall be made ready at concerned sites before receipt of Transformer/Reactors units. All the requisite material for Neutral & Delta Bus formation required for charging of complete bank of 765KV class 1-ph Transformer/Reactor units shall be made available at the concerned sites before receipt of the Transformer/Reactor units at site.
- 8.3.23 The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub-Contractor.

9.0 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 type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipments/ material already accepted in ENDCUSTOMER shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by ENDCUSTOMER/representative authorized by ENDCUSTOMER/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies(NABCB) certified agency shall also be acceptable.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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

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

Note

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

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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-J.

10.0 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 precommissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Employer will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 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.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3.4 PRECOMMISSIONING, 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 procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

(i) Pre commissioning : As per relevant Sections

(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 72 (Seventy two) hours continuously. In case of interruption due to problem/ failure in the respective equipment, the contractor shall rectify the

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

problem and after rectification, continuous 72 (Seventy two) 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. However necessary fee shall be reimbursed by ENDCUSTOMER on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the 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, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 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

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above **and 900 gm/sq.m for coastal area (if defined in Section Project)** 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/sq.m minimum **and 900 gm/sq.m for coastal area (if specified in Section-Project)**.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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.

12.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate or alternate approved treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to four numbers of one minute dips in copper sulphate solution as per IS-2633.

12.2.5 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

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of touch-up zinc rich paint at site shall be allowed with approval of Engineer Incharge.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS6005 "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 swarf 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.

12.3.2 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.

12.3.3 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.

12.3.4 The exterior and interior colour 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 equipments. Glossy white colour inside the equipments /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with 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 equipments.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

12.3.5 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.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
<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>			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.



Base Colour Direction of flow Band Colour

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium 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.

12.3.8 Band colour is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band colour shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.

13.0 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, workmanlike 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 energisation at rated voltage.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 13.2 Contractor 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 (as per Drawing No. CENGG-CVL-STD-PLATFORM-01, Rev.0) 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 equipments including control & protection panels, Communication equipments and operating mechanism boxes etc. of outdoor equipments 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 shall 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 to 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, damages 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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 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 Equipments, 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 BPS.

14.0 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 damages 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 detail engineering and the same shall be supplied without any additional cost implication to the Employer.

14.3 FACILITIES TO BE PROVIDED BY THE EMPLOYER

14.3.1 Employer shall make available the auxiliary supplies at a single point in the substation on chargeable basis. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 14.3.2 Employer shall make available construction water supply at a single point in the substation. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

15.0 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 under. 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.

16.0 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 alongwith 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 metres.

17.0 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 :

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Sl. No.	Description	Materials
a)	For connecting ACSR conductors/AAC conductors/ Aluminium tube	Aluminum alloy casting, conforming to designation 4600 of IS:617 and all test 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 test shall conform to IS:617
c)	For connecting G.I	Galvanised mild steel shield wire
d)	Bolts, nuts & plain washers	Electro-galvanised for sizes below M12, for others hot dip galvanised.
e)	Spring washers	Electro-galvanised mild steel suitable for atleast 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 are 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 particular case, are also included in the scope of Work.
- 17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. 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 or through (fixed/sliding) type connection of IPS AL tube as required. In both the cases the clamp height (top of the mounting pad to centre 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 once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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

18.0 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 IS/IEC 61439-0, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes, Out door ACDB cum DCDB panels shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 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 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 to be also done on non-conducting sheet.

For CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES FOR OUTDOOR EQUIPMENT Junction Box, wire should be as per IS or equivalent IEC with FRLS 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 rain water.

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. Ventilating Louvers, if provided, shall have screen 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) in order 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 weather proof 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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 armour 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 of 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 by the use of 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 plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 The following routine tests alongwith 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 IS/IEC60947 including application of 1kV rms for 1 (one) minute, after IP-55 test.

19.0 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.

20.0 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 of moulded

piece, 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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 arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, nondeteriorating 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 copper flexible. | Minimum of two of 2.5 sq mm | CT/PT | circuits |
| b) | All CT/PT circuits flexible. | Minimum of 4 nos. of 2.5 sq mm | | copper |

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals 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.

21.0 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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 of hand lamps.

21.3 Switches and Fuses:

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of 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.

21.3.2 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.

22.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:

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

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 galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Void

22.9 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-H**.

22.10 In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creep age (31mm/kV) of the switchgear/equipment's, insulator strings, bushings & bus post insulators etc., Design, supply & erection of such structures shall be in the scope of contractor against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipment's.

23.0 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 indoor 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 so located 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 over loaded at any operating point of driven equipment that will rise in service.
- b) Motor shall be capable at 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:

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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 alongwith 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:325.
- 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 atleast 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 degree C shall be within the limits specified in IS:325 (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 specialities 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 alongwith 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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

NOA: means Notification 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 atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered 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 NOA.
 - b) In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered 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 atleast two (2) years as on the date of NOA.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.
 - b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.
 - c) the collaborator shall furnish performance guarantee for an amount of **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 atleast two (2) years as on the date of NOA.

OR

The Manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA and the bidder should have designed, manufactured, tested & supplied 345 kV or higher voltage class one (1) number 3-phase Reactor of at least 50 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 16.7 MVAR and the same Transformer(s) & Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) 715 kV or higher voltage class either One (1) no. 1-phase Reactor of at least 80 MVAR capacity or One (1) no. 1-phase Transformer of at least 166 MVA capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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 3phase 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 atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) 220kV (applicable for supply of 400kV class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kVclass Transformer)or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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. 1phase 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. 1phase 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. 1phase 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 atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.
 - b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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 atleast 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.
 - (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.
- OR
- b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

24.7 Technical Requirement for 220KV,132kV,110kV Grade XLPE Power Cables

- (i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/132kV/110kV* or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/132kV/110kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.

OR

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/132kV/110kV* or higher grade XLPE insulated Cable as on the date of NOA.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor

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 atleast 5 (five) km of single core, 66kV or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) 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 atleast one (1) year as on the date of NOA.

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 atleast 100 Kms of 1.1kV grade PVC insulated control cables as on the date of NOA. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA.

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 atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.

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

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 atleast 50 nos. draw out circuit breaker panels,

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

out of which atleast 5 nos. should have been with relay and protection schemes with current transformer. He must have also manufactured atleast 50 nos. MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which must be in satisfactory operation# as on the date of NOA.

- 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, atleast one hundred circuit breakers of the make and type being offered must have been in satisfactory operation# as on the date of NOA.

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 atleast 600 AH and these must be satisfactory operation# for atleast two (2) years in power sector or industrial installations as on the date of NOA.

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 atleast ten (10) KW and these must have been in satisfactory operation# as on the date of NOA.

24.15 Technical Requirements for LT Transformer

- i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 315kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.
- ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that At least 33kV class of 315kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA.

Note In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 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

24.16 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 atleast two (2) years as on the date of NOA.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation[#] as on the date of NOA.
 - b) Contractor shall furnish performance guarantee for an amount of 10% of the exworks cost of the equipments(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 equipments(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 atleast two (2) years as on the date of NOA.

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 (atleast 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 atleast two (2) years as on the date of NOA.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- (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 NOA.
 - 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 equipments 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 NOA

24.20 Technical Requirement for 400kV GIS Equipment

- (i) The manufacturer whose 400kV GIS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
 - a) Atleast one no. 345kV or above voltage class GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above CB bay (as per IEC or equivalent standard) as on the date of NOA.
 - b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV or above voltage level GIS equipment in India, shall be submitted.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 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

25.0 Technical Requirement of Sub-contractors:

The sub-contractor must have either of the following experience of having successfully completed similar works during last 7 years as on the last day of month previous to the one in which the sub-contractor is proposed to be engaged:

- a) Three similar works costing not less than the amount equal to 40% of the cost of the work to be sub-contracted.

OR

- b) Two similar works costing not less than the amount equal to 50% of the cost of the work to be sub-contracted.

OR

- c) One similar work costing not less than the amount equal to 80% of the cost of the work to be sub-contracted.

1. Minimum Average Annual Turnover ******(MAAT) for best three years i.e. 36 months out of last five financial years of the sub-contractor should be.....:

******Annual Gross Revenue from operations/ Gross operating income as incorporated in the profit & loss account excluding Other Income.

Note:

- a) Similar work shall mean the work which are of similar in nature to the work to be sub-contracted e.g. for the scope of civil work to be sub-contracted, the experience should be of civil work.
- b) The aforesaid qualifying requirement shall however, not be applicable for engaging labour as per extant policy.
- c) The cost of the work to be sub-contracted shall be considered as available in the Contract Agreement. However, if the value is not available in the Contract Agreement, the same shall be the estimated value for such work.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- d) The above criteria is in addition to extant policy on selection of sub-contractor as per WPPP, Vol-II.
- e) The MAAT requirement shall be worked out basis the following formula:

$$\text{Minimum Average (MAAT)} = \frac{\text{Cost of the work to be subAnnual Turnover contracted} \times 1.5}{\text{Completion period in years}^{**}}$$

******The completion period shall be considered as 1 year even if the same is less than 1 year.

26.0 Technical Requirement of Sub-contractors of GIS Packages

In case of GIS is supplied from Indian GIS manufacturer, the erection, testing & commissioning of GIS shall be executed either by the bidder himself or by the Subcontractor meeting the following technical requirement:

The bidder/Subcontractor must have erected, tested and commissioned at least two (2) nos. GIS/AIS Circuit breaker equipped bays@ of voltage class** as specified below or higher in one (1) substation or switchyard during the last seven (7) years and these bays must be in satisfactory operation# as on the date of NOA.

S.no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)
1	765kV & 400kV GIS	345kV
2	220kV	220kV
3	132kV	110kV
4	66kV	66kV

Further, the sub-contractor shall also meet the requirement specified at Clause No. 25.0 of this section.

Note:

1. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear.
2. # satisfactory operation means certificate issued by the Owner/Utility certifying the operation without any adverse remark.

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 SpecialCommittee 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. 107-1964.
- 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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,

ANNEXURE-A

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 test 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 107-1964 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 micro volts 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Technical Specification: GTR
C/ENGG/SPEC/GTR (Rev. No.: -15, Dec 2020)

Page 2 of 2

ANNEXURE-B

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 shall also be acceptable**

The Bidder shall arrange to transport the structure from his Contractor’s premises/ ENDCUSTOMER 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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Technical Specification: GTR
C/ENGG/SPEC/GTR (Rev. No.: -15, Dec 2020)

Page 1 of 1 (Annexure-B)

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 (P1 to P3)	Methods of High Voltage Testing
IS-12063	Classification of degrees of protection provided by enclosures of electrical equipment
IS-2165 ; P1:1997, P2:1983	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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

CODES	TITLE
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	Technique 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 ICSI109
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

CODES	TITLE
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

CODES	TITLE
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

CODES	TITLE
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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 vulcanised 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 gasinsulated 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	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

IS-2705- (P1 to P4)	Current Transformers
CODES	TITLE
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: Ferroresonance 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	IEE 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

CODES	TITLE
	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	Moulded 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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 Side-Band) power line carrier systems
CIGRE	Teleprotection 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)

CODES	TITLE
	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 metres
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	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

CODES	TITLE
	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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
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 (Bus-bars)
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

CODES	TITLE
IS:2959	AC Contactors for Voltages not Exceeding 1000 Volts
IS:1248	Indicating Instruments
IS:2208	HRC Fuses
IS:13947 (Part-3)	Air break 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	Colours 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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 armouring of cables
IS-5831	PVC insulating and sheath of electric cables
IS-6380	Elastometric insulating and sheath of electric cables
IS-7098	Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100 volts
IS-7098	Cross-linked polyethyle insulated PVC sheathed cables for working voltage from 3.3kV upto 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

CODES	TITLE
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 colours 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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 Galvanised 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

CODES	TITLE
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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
CODES	TITLE
IS:5120	Technical requirement – Rotodynamic special purpose pumps

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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	Colour 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)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

CODES	TITLE
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)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

CODES	TITLE
IS:2147	Degree of protection
IS:5	Colour 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	Pressurised Water Type
D.G. SET	
IS:10002	Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

CODES	TITLE
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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 colombium-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

CODES	TITLE
Piping and pressure vessels	
IS-1239 (Part 1 and 2)	Mild steel tubes, tubulars and other wrought steel fittings

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

ANSI-B31.1	Power piping
ANSI-B36.10	Welded and seamless wrought steel pipe
ANSI-B36.9	Stainless steel pipe
Other civil works standards	

CODES	TITLE
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 appliancescode 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

IS-2645	Integral cement waterproofing compounds
IS-3025 (Part 1 to Part 48)	Methods of sampling and test (Physical and chemical) for water and waste water
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)

CODES	TITLE
	rame land 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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 Galvanising on Iron and Steel
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles
IS:4826/ ASTMA-472-729	Hot dip galvanised 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 Galvanising 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 Galvanised 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

CODES	TITLE
Lighting Fixtures and Accessories	
IS:1913	General and safety requirements for electric lighting fittings
IS:3528	Water proof 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 under ground in mines (nonflameproof type)
IS:10322	Specification for flood light
IS:10322	Specification for decorative lighting outfits

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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	Water tight 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
CODES	TITLE
IS:9224	HRC Cartridge fuse links for voltage above 650V(Part-2)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-C

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
CODES	TITLE
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 galvanising

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

LIST OF DRAWINGS/DOCUMENTS FOR SECOND ADVANCE

A. ELECTRICAL DRAWINGS/DOCUMENTS FOR SWITCHYARD

- (1) Single Line Diagram
- (2) Electrical Layout – Plan and Sections
- (3) DSLP Calculation and drawing
- (4) Structure Layout (Plan & Section) drawing
- (5) Foundation & Cable Trench Layout
- (6) Earthmat Layout
- (7) Short circuit Force and Critical Span Calculations (for non-standard span)
- (8) Cantilever Strength calculations (for non-standard span)

B. CIVIL DRAWINGS/DOCUMENTS

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

C. DRAWINGS/DOCUMENTS OF EQUIPMENT

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

D. DRAWINGS/DOCUMENTS OF POWER TRANSFORMER

- (1) Design Review documents
- (2) GA drawings for transformer, bushings
- (3) Foundation Plan
- (4) GTP
- (5) RTCC - GA and schematic drawings
- (6) Rating and Diagram Plate

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- (7) Power Transformer foundation design & drawings (if Applicable)
- (8) For Single Phase Autotransformer (if Applicable)
 - Single Line Diagram
 - Electrical Layout & Section
 - Foundation Layout including Neutral & Delta Formation

1 of 2 (Annexure-D)

-15, Dec 2020)

ANNEXURE-D

LIST OF DRAWINGS/DOCUMENTS FOR SECOND ADVANCE

E. DRAWINGS/DOCUMENTS OF REACTOR

- (1) Design Review documents
- (2) GA drawings for reactor, NGR, LA, bushings
- (3) Foundation Plan
- (4) GTP
- (5) Rating and Diagram Plate
- (6) Shunt Reactor, NGR & SA foundation design & drawings (if Applicable)
- (7) For Single Phase Reactor (if Applicable)
 - Single Line Diagram
 - Electrical Layout & Section
 - Foundation Layout including Neutral Formation

F. DRAWINGS/DOCUMENTS OF GIS

- (1) GTP
- (2) Gas Line Diagram
- (3) GIS Layout Drawing

G. DRAWINGS/DOCUMENTS OF EHV Cable (132kV of Above)

- (1) GTP
- (2) 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 for a particular substation package.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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.

2 of 2 (Annexure-D)

-15, Dec 2020)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

Comprehensive List of Drawing Submission Schedule		
SL.NO.	DRAWINGS/DOCUMENTS TITLE	CATEGORY
1.00	DRAWING FOR SWITCHYARD	
1.01	Over all 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	Earthmat 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	Out door 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

2.04	Battery sizing calculation (if applicable)	R
2.05	Hydrolic 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

Comprehensive List of Drawing Submission Schedule		
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 Analyser	R
d)	Partial discharge monitoring system	R
e)	catalogue of UHF sensors	R

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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	Magnetising Characteristics of bushings CT	A
4.11	Rating and Diagram plate	A

Comprehensive List of Drawing Submission Schedule		
4.12	Valve Schedule plate rating	A
4.13	Twin-Bi directional 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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 drg 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

Comprehensive List of Drawing Submission Schedule		
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	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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. interpolate	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	

Comprehensive List of Drawing Submission Schedule		
10.01	GA of Surge Arrester	A
10.02	GTP	A

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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 drg 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

16.00	INSULATOR STRINGS WITH HARDWARE ASSEMBLY	
16.01	GA DRG	A
16.02	Component drawings	R
16.03	Type Test Reports	A

Comprehensive List of Drawing Submission Schedule		
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 drg. of lighting poles/posts	A
20.03	Wiring drgs. 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 drg of ACDB	A
21.02	SLD of ACDB	A
21.03	GA drg of 220V DCDB	A

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

21.04	SLD of 220V DCDB	A
21.05	GA drg 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

Comprehensive List of Drawing Submission Schedule		
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 Equipments	A/R
24.02	Type Test Reports of all relays & equipments	R
	GA and schematic drgs. 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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 drg 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 equipments	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	

Comprehensive List of Drawing Submission Schedule		
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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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 stainers (Y type & basket strainer)	A
30.08	Drawing of valve pit details	A
30.09	System writeup with various settings	A
30.10	GTP & drgs. 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 quatrroid bulb detector	A
30.13	GTP & drg. 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
Comprehensive List of Drawing Submission Schedule		
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)	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-E**

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) in DREAMS System.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Annexure- F

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. Formats for RM, in process and acceptance testing
12. Type test approvals conducted in last 5 years, if applicable
13. Performance Certificates from customers
14. Photographs of factory, plant and machinery & testing facilities

Dec
MQP & INSPECTION LEVEL REQUIREMENT

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
A.01	LT Transformer /Power Transformer/ Reactor/ Converter Transformer/ Filter Reactor	MQP/ITP	IV
A.02	Bushing	MQP	IV
A.03	Insulating Oil	ENDCUSTOMER TS	III
A.04	Oil storage tank for transformers	MQP	III
A.05	Nitrogen injection based explosion prevention system	FAT/ITP	III
A.06	On Line oil drying system for transformers	ENDCUSTOMER TS	II**
A.07	On Line DGA and moisture monitoring system	ENDCUSTOMER TS	II**
A.08	Flow sensitive conservator isolation valve	ENDCUSTOMER TS	II**
A.09	Oil Filtration Machine	MQP	III
B.01	Circuit Breakers	MQP	IV
B.02	Current Transformers	MQP/ITP	IV
B.03	CVT/PT/IVT	MQP	IV
B.04	Isolators	MQP/ITP	IV
B.05	Surge Arrestors	MQP/ITP	III
B.06	Line Trap & Air Core Reactor	MQP/ITP	III
B.07	Point On switching device (CSD) for Circuit Breaker (wherever required)	FAT/ITP	IV
C.01	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	ITP	IV

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

C.02	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	ITP	IV
C.03	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	ITP	IV
C.04	Harmonic Pass filters	ITP	IV
C.05	HT Capacitor	MQP	IV
D.01	Thyristor Valve	FAT/ITP	III
D.02	PLC Capacitors for HVDC	FAT/ITP	III
D.03	Valve Cooling system for	FAT/ITP	III

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	HVDC		
D.04	AC/DC Filter Resistors	ITP	III
D.05	DC Current and Voltage measuring device for HVDC	FAT/ITP	III
D.06	Maintenance platform for valve hall	ENDCUSTOMER TS	II
D.07	Optical signal column for FSC	FAT/ITP	II
E.01	GIS including spares	MQP/ITP	IV
E.02	Dew Point Meter for GIS	ENDCUSTOMER TS	I*
E.03	Portable Partial Discharge monitoring system for GIS	ENDCUSTOMER TS	I*
E.04	Partial Discharge Monitoring System (Online) for GIS	ITP	III
E.05	PEB Structure and Puf Panels	MQP	III
F.01	Substation Automation system	FAT/MQP	III
F.02	Event Logger	ENDCUSTOMER TS	III
F.03	PLCC equipment Viz PLCC Terminal ,Carrier equipment, Protection Coupler , Coupling Device but excluding EPAX / HF Cable	MQP	III
F.04	Control & Relay Panels	MQP	III
G.01	EHV Cables	MQP/ITP	III
G.02	Power Cables & Control Cables	MQP	III

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

G.03	Cable Joints (11 kV and above)	ENDCUSTOMER TS	II
G.04	Cable Lugs & Glands / Clamps/Terminations	ENDCUSTOMER TS	I
H.01	LT Switchgear & ACDB/DCDB/MLDB/ELDB	MQP	III
H.02	Battery	ENDCUSTOMER TS	II
H.03	Battery Charger	MQP	III
H.04	UPS & Voltage Stabilizer	MQP/FAT	III
H.05	D. G. Set	FAT/ITP	III
H.06	Lighting Panel	ENDCUSTOMER TS	II
H.07	Lighting Poles	ENDCUSTOMER TS	II
H.08.1	Lighting Fixtures, Lighting Earthwire, Switches / sockets, Conduits, Lamps & fans including exhaust fans	ENDCUSTOMER TS	I
H.8.2	Solar based LEDs System including street light/pole solar panel, Inverter controller/LED fixture	FAT	III
H.09	MS/GI /PVC Pipes for cable	ENDCUSTOMER TS	I

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	trenches and lighting		
H.10	Outdoor Receptacle	ENDCUSTOMER TS	I
H.11	Split A.C/window A.C./ precision AC/ Kiosk AC/ Cascade AC/ Tower AC	ENDCUSTOMER TS	I
H.12	Occupancy sensors for control of lighting	ENDCUSTOMER TS	I
H.13	Solar based street lighting pole including Solar Panel, Inverter, Controller, etc.	ENDCUSTOMER TS	III
H.14	Junction Box / Lighting Switch Boards / Bay MB / Portable Flood Light Panel	ENDCUSTOMER TS	II

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

H.15	Lighting transformer	ENDCUSTOMER TS	II
I.01	SF6 gas processing unit, SF6 gas Leakage detector, SF6 gas Analyzer	ENDCUSTOMER TS	I*
I.02	SF6 Gas	ENDCUSTOMER TS	I
I.03	Spark Gap	FAT/ITP	III
I.04	Time synchronizing Equipment (GPS Clock)	ENDCUSTOMER TS	I
I.05	Galvanized Cable trays	ENDCUSTOMER TS	II
I.06	Video Monitoring System	FAT/ITP	I
I.07	Public Address System (All Components)	ENDCUSTOMER TS	I
I.08	Building Management System (All components)	ENDCUSTOMER TS	I
I.09	Access Control System (All Components)	ENDCUSTOMER TS	I
I.10	Video Display system/ Video Projection system	ENDCUSTOMER TS	I
I.11	VESDA (smoke detector)	ENDCUSTOMER TS	I
I.12	High Mast Pole	MQP	III
J.01	Aluminium ladder	ENDCUSTOMER TS	I
J.02	Hume Pipes	ENDCUSTOMER TS	I
J.03	Castle Key	ENDCUSTOMER TS	I
J.04	Water Treatment plant (All components).	ENDCUSTOMER TS	I
J.05	Furniture	ENDCUSTOMER TS	I
J.06	DOL Starter	ENDCUSTOMER TS	I
J.07	Oil Sample Bottles and Syringe	ENDCUSTOMER TS	I
J.08	Test & Measuring Equipment, T&P	ENDCUSTOMER TS	I*
K.01	EOT Crane	ENDCUSTOMER TS	II

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
K.02	Boom Crane/Golf Cart/Platform Truck/Man Lift/ Fork Lift/ Lifts	ENDCUSTOMER TS	II
L.00	Fire Protection System		
L.001	Panels, Hydro pneumatic tank for fire protection system.	ENDCUSTOMER TS	III
L.002	Deluge valve, Strainers, MS/GI pipes, Pumps, motors, air compressor, and other valves, Diesel Engines	ENDCUSTOMER TS	II
L.003	Others	ENDCUSTOMER TS	I
M.00	HVAC SYSTEM		
M.001	Air Cooled Chiller	ENDCUSTOMER TS	III
M.002	Pump	ENDCUSTOMER TS	II
M.003	Air Handling Unit	ENDCUSTOMER TS	II
M.004	Fan Filter Unit With Centrifugal Blower	ENDCUSTOMER TS	II
M.005	Axial Flow Fan	ENDCUSTOMER TS	II
M.006	Main Climate Control Unit (Dehumidifier)	ENDCUSTOMER TS	I
M.007	Dampers	ENDCUSTOMER TS	II
M.008	Fire Dampers	ENDCUSTOMER TS	II
M.009	Pressure Gauge, Thermometers, Other Instruments / Sensors	ENDCUSTOMER TS	I
M.010	Grill, Diffuser, Jet Nozzle, Louvers etc	ENDCUSTOMER TS	I
M.011	Ducting	ENDCUSTOMER TS	III
M.012	M S Pipe	ENDCUSTOMER TS	II
M.013	Pipe Insulation Material	ENDCUSTOMER TS	I
M.014	Duct Insulation Material	ENDCUSTOMER TS	I

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

M.015	Underdeck Insulation Material	ENDCUSTOMER TS	I
M.016	Gate Valve & Non Return valve	ENDCUSTOMER TS	I
M.017	Y Strainer	ENDCUSTOMER TS	II
M.018	Ball Valve/ Motorised Butterfly Valve/ Balancing Valve	ENDCUSTOMER TS	I
M.019	Closed Expansion Tank	ENDCUSTOMER TS	II
M.020	Air Separator	ENDCUSTOMER TS	I
M.021	MCC /PLC /Electrical Panels	ENDCUSTOMER TS	III
M.022	Propeller Fan/ Conduit	ENDCUSTOMER TS	II
M.023	Air Filter/ Mixing Valve with Thermostat	ENDCUSTOMER TS	I

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
N.01	SDH Equipment	FAT/ITP	IV
N.02	Termination Equipment Primary/ DI Multiplexer	FAT/ITP	IV
N.03	DACS	FAT/ITP	IV
N.04	Optical Amplifier	FAT/ITP	IV
N.05	FODP including pigtail, Joint Box, FDMS	FAT/ITP	II
N.06	IMPS	FAT/ITP	IV
N.07	Optical bypass switch	FAT/ITP	IV
N.08	Air Purifier	FAT/ITP	I
N.09	Patch cord & connector	FAT/ITP	I
N.10	NMS	FAT/ITP	IV
N.11	OPGW Cable	MQP/ITP/FAT	III
N.12	Hardware Fittings for OPGW cable	MQP/ITP	III
N.13	DCPS	FAT/ITP	III
N.14	Radio Links	FAT/ITP	III
N.15	SMPS based DC Power Supply (DCPS) system	FAT/ITP	III
N.16	WAMS (PMU & Accessories)	FAT/ITP	III
N.17	PUF Shelter	FAT/ITP	III

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

N.18	Aerial OFC/UGOFC/ADSS/FO Cable	FAT/ITP	III
N.19	DWDM	FAT/ITP	III
N.20	OTN	FAT/ITP	III
N.21	MPLS-TP Equipment	FAT/ITP	III
N.22	L2 Switch	FAT/ITP	III
N.23	IP-MPLS Router	FAT/ITP	III
N.24	HDPE Pipes	ENDCUSTOMER TS	II
N.25	Equipment Cabinets	ENDCUSTOMER TS	II
N.26	Main Distribution Frame	ENDCUSTOMER TS	I
N.27	Telephone system, EPAX, Telephone wires, Telephone sockets	ENDCUSTOMER TS	I
N.28	Fibre Optic Cable	MQP	III
N.29	Hardware Fittings for Fibre Optic cable	MQP	III
O.01	Re-rollers of MS/HT Angle Section and galvanized tower parts.	MQP	IV
O.02	Conductor	MQP	IV
O.03	Hardware fittings and Conductor & Earthwire Accessories	MQP	IV
O.04	Earth wire	MQP	IV
Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
O.05	Insulator	MQP	IV
O.06	Bolts & Nuts of Gr 8.8 / 8	MQP	IV
O.07	Mono Pole	MQP	IV
O.08	Foundation Bolts & Anchor Bolts	ENDCUSTOMER TS	III
O.09	D-shackle/ Hanger / Links and associated Special bolt/nuts	MQP	III
O.10	Span Marker, Obstruction lights and Wind Measuring Equipment	ENDCUSTOMER TS	III
O.11	MS ROD rolled by Approved Re-roller of ENDCUSTOMER	MQP	III
O.12	MS ROD rolled by Approved steel producers of ENDCUSTOMER	ENDCUSTOMER TS	I

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Annexure-G

O.13	Spring Washers & Pack washers	ENDCUSTOMER TS	II
O.14	Bolts & Nuts Gr up to 5.6/5	ENDCUSTOMER TS	II
O.15	ACD & Barbed wire for ACD/Bird guard	ENDCUSTOMER TS	II
O.16	Danger Plate /Phase Plate / Number Plate / Circuit plate	ENDCUSTOMER TS	I
O.17	Sub Station Structure (lattice/pipe type)	MQP	III
O.18	Clamps & Connectors (including equipment connectors)	MQP	III
O.19	MS/ GI Flat, rod type, pipe type and other earthing material.	ENDCUSTOMER TS	II
O.20	Aluminium Tube & Busbar materials	ENDCUSTOMER TS	II
O.21	Pipe Type & Counter Poise Earthing	ENDCUSTOMER TS	II
O.22	DTS System	ENDCUSTOMER TS	II
<p>For Equipment where requirement of MQP is envisaged, ITP/FAT will be followed If sourced from off shore. For items required in S/S or T/L or TELECOM/LD&C , same inspection level as specified shall be followed for all the cases.</p> <p>* MICC for test and measuring equipment (inspection level I or II) shall be issued only after actual verification/ demonstration of satisfactory performance at site.</p> <p>** Though level-2 items, CIP/MICC can be issued also on review of TCs and visual inspection of these item.</p>			

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 equipments 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 this 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

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-H

RTV Silicone high voltage insulation coating (HVIC)

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% tolerance, 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

RTV Silicone high voltage insulation coating (HVIC)

Dry Arc resistance	Tract \geq 140 seconds Burn Out \geq 420 seconds
Parameters	Requirement
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

- 4.3.1 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.
- 4.3.2 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.
- 4.3.3 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.
- 4.3.5 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.
- 4.3.6 The RTV Silicone high voltage insulation coating shall exhibit long-term water repellency and hydrophobicity.
- 4.3.7 The RTV Silicone high voltage insulation coating shall not require use of any primer on the ceramic insulators for adhesion purposes.
- 4.3.8 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.
- 4.3.9 The RTV Silicone high voltage insulation coating shall have a minimum 12 months 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.

RTV Silicone high voltage insulation coating (HVIC)

4.4 Composition and Properties

- 4.4.1 The RTV Silicone high voltage insulation coating shall be capable of withstanding high-pressure water power washing. To prove this property, a power wash test shall be performed per requirements stated hereafter in this standard.
- 4.4.2 The RTV Silicone high voltage insulation coating shall protect the ceramic insulators (porcelain and glass) against flashovers caused by pollution.
- 4.4.3 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.
- 4.4.4 The warranty for RTV coating on the equipments shall be for a period of 5 years

4.5 Markings

The packing and expiry dates of coating shall be labeled 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.

5.0 TESTS

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

5.1 Type Tests

- 5.1.1 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 (± 0.5 mm) 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.

RTV Silicone high voltage insulation coating (HVIC)

- 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 :

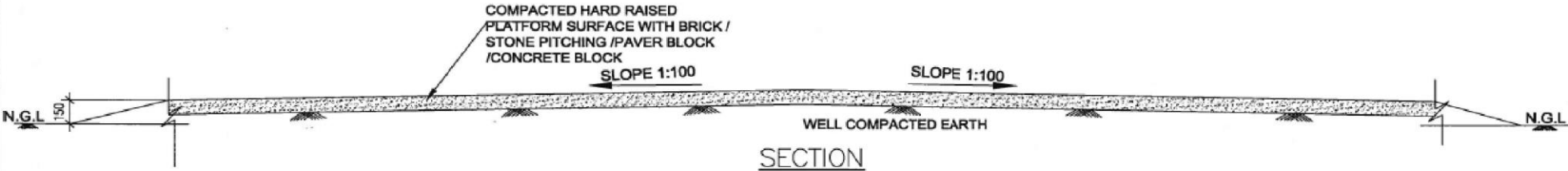
Hydrophobicity test shall be carried out on virgin material at site on 5% sample on 1-2 coated equipment as per STRI guidelines and the results shall be HC2 class or better. Hydrophobicity test shall be carried out after completion of high pressure water withstand test.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-H


RTV Silicone high voltage insulation coating (HVIC)


Annexure-I



SECTION

INDICATIVE DRAWING ONLY
(SIZE SHALL BE AS PER WORK
REQUIREMENT)

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)			
PROJECT:		STANDARD DRAWING FOR OPEN PLATFORM	
TITLE:		INDICATIVE DRAWINGS FOR OPEN STORAGE PLATFORM	
DRAWING NO.	C-ENGG-CVL-STD-PLATFORM-01	SCALE	REV

 11/9/16				11/8/16
ACD(ENGG CIVIL)	CDB(ENGG CIVIL)	REV. BY ACM(ENGG CIVIL)	APVD. BY CM(ENGG CIVIL)	DATE

ANNEXURE-J

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.	Out door 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, ITLAY [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- MS15-SHB-PS (Plug & Socket type)] /

ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

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, MALAYSIA / (iv) SHENYANG HONGDA GENERAL RUBBER FACTORY /

Sl. No.	ITEM DESCRIPTION	MAKE
		(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, 22]/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 CS46518, 900-003-32 CS-46369] / (ii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No.SYJ9-50-25 TH]
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-SOHE-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 /

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

		(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 CS46518, 900-003-32 CS-46369] / (ii) VIAT INSTRUMENTS [Model/Drawing No.950 / (iii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No.SYJ9-50-25 TH]
30.	RIP Bushing (52kV, 3150A)	ABB Micafil, Switzerland [Model/Drawing No. 1ZCD073617 (Rev F)]
31.	RIP Bushing (420kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005378A0001 REV. 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

Sl. No.	ITEM DESCRIPTION	MAKE
		(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)]

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

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-2550-16002500-0.6-B, 1ZSC026186-AAM REV. H]
52.	OIP Bushing (420kV, 2500A)	ABB, SWEDEN [Model / Drawing No.GOE-1425-11502500-0.6, 1ZSC026186-AAL REV. F]
53.	OIP Bushing (800kV, 2500A)	TBEA, CHINA [Model / Drawing No.TBEA-500-765TA0035-01, REV. 02]
54.	OIP Bushing (420kV, 2500A)	TBEA, CHINA [Model / Drawing No.TBEA-500-765TA0035-02, 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]
Sl. No.	ITEM DESCRIPTION	MAKE
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.TRANSDDRY CD-002]

ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-K**

SL.NO.	Power System Equipment
A	Power System Equipment
1	Transformers and Reactors (66 kV to 765 kV AC)
2	Air Insulated Switchgear (Circuit Breakers, Disconnectors), Surge Arrester, Wave trap (66 kV to 765 kV AC)
3	Gas Insulated Switchgear (66 kV to 400 kV AC)
4	Instrument Transformers (66 kV to 765 kV AC)
5	Bus Post Insulators
6	Substation structure material
7	Transmission line tower material
8	Conventional conductors and accessories
9	Porcelain Insulators and hardware fittings
10	Control & power cables
11	High Voltage Cables (upto 220 kV AC)
12	Control and Protection System including Substation Automation System
13	DG set
14	DC system (DC Battery & Battery Charger) in a substation
15	AC & DC Distribution Board for substation
16	Material for Grounding system
17	Items for illumination system
B	Telecom Products, Services and Works
1	Encryption/UTM platforms (TDM and IP)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-K**

2	IP/MPLS Core routers/ Edge/ Enterprise Router
3	Managed Leased line Network equipment
4	Ethernet Switches (L2 and L3), Hubs
5	IP based Soft Switches, IMS, Unified Communication Systems

6	Wireless/Wireline PABXs / IP PBX & / Media Gateways
7	CPE (including Wi-Fi Access points and Routers, Media Converters), 2G/3G/4G/LTE Modems, Leased-line Modems, NFV/SDN CPE
8	Set-Top Boxes
9	SDH/Carrier-Ethernet/MPLS- TP/ Packet Optical Transport equipment/PTN/OTN systems
10	DWDM/CWDM systems
11	GPON/XGS-PON, NG-PON2 equipment (including ONT and OLT)
12	Optical/SDH/PDH Cross Connects/OTN Cross-connects and optical MUX, OADM
13	Small size 2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH
14	2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH
15	Small Size LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNodeB, Small Cells, EPC, NIB CRAN BBU and RRH, LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)
16	LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)
17	Wi-Fi based broadband wireless access systems (Including Access Point, Aggregation Block, Core Block), Integrated Broadband system

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-K**

18	Microwave Radio systems (IP/Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI)
19	Software Defined Radio, Cognitive Radio systems
20	Repeaters (RF/RF-over-Optical), IBS, and Distributed Antenna system
21	Satellite based systems-Hubs, VSAT Disaster Communication Systems etc.
22	Copper access systems (DSL/DSLAM), high-speed xDSL (G.fast)
23	Network Management systems (NMS) with its various derivatives
24	Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems
25	Optical Fiber
26	Optical Fiber Cable
27	Telecom Power System (Including Solar Power)
28	Telecom Batteries (Lead Acid & Li-ion)
29	IP audio phones / IP video Phones / Analog adaptor
30	SDN Software Controllers, NVF and CNF software
31	Telecom Cloud infrastructure, Telecom Data centers
32	2 way Analog/Digital radio including Walkie-Talkie & Mobile Radio
33	Batteries of 2 way Analog/Digital radio including Walkie-Talkie
34	Fiber Monitoring System
35	M2M/IOT Subsystems
36	Telecom Services/Works

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

S.No	Clause ref	Existing Clause	Proposed Text	Reason/Background for proposed changes
1.	Clause 2.1 a)		<p>All equipment/materials/items, as per Annexure-K, as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only</p> <p>Equipment/material/item/parts/component (comprising of embedded system) to be supplied under the contract shall be tested in laboratories to check for any kind of embedded cyber threats and for adherence to Indian Standards as issued by Ministry of Power/Govt. of India from time of such import from specified "prior reference" requirement of prior permission from the Govt. of India including protocol of designated laboratories Govt. of India shall also be complied with by the contractor.</p> <p>Contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the contractor the procedure of safe disposal at the time of closing of the contract</p>	New Clause Added..
2.	Clause 2.6	The bidder shall be responsible for safety of human and equipment during the working.....	The contractor shall be responsible for safety of human and equipment during working.	
3.	Clause 3.2	The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening) of standard specified under Annexure-C of this section, unless specifically mentioned in the specification.	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 standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification at Annex-C is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS.	Changes incorporated In line with recent Guidelines from GOI.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			If the IS standard is not available for an equipment/material, then other applicable International standard	
			(IEC/Equivalent), as per the specification, shall be accepted.	
4.	Clause 3.3	The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.	The Contractor shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.	
5.	Clause 3.4	The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.	The equipment offered by the contractor shall confirm to relevant IS standard. The list of such IS standards are given at Annexure-C. In case There is discrepancy between IS and other international standard then provision in IS shall prevail. The Contractor shall also note that list of standards presented in this specification 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 relevant equipment's/ Material is supplied from foreign country, then other internationally standard (IEC/Equivalent) will be accepted.	Changes incorporated In line with recent Guidelines from GOI
6.	Clause 4.1	The 800kV and 420kV system is being designed to limit the switching surge over voltage of 1.9 p.u.	Switching surge over voltage and power frequency over voltage is specified in the system parameters below	To avoid repetition.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		and 2.5 p.u., respectively and the power frequency over voltage of 1.4 p.u. and 1.5 p.u., respectively. In case of the 420kV system, the initial value of the temporary overvoltages could be 2.0 p.u. 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 over voltage conditions.	system, the initial value of the temporary over. In case of the 420kV for 1-2 cycles. The equipment furnished and perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions						
7.	Clause 4.4	The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.	The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.	Contractor shall design terminal connectors of the equipment taking into account various forces that are required to withstand.					
8.	Clause 4.6	4.6 System parameters 132kV,66kV,33kV & 11kV System S.No Description of 66kV System parameters 9 Rated Short 31.5kA f circuit current							
			9.	Clause 5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data detailed bill of quantity and 1 (one) set of test reports for the approval of the Employer. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.					
			10.	Clause 5.7 Approval Procedure Note (2)					
				All drawings should be submitted in softcopy form, however 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					
				4.6 System parameters 132kV,52kV 66kV,33kV & 11kV System S.No Descripti 66kV System on of parameter					

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

9 Rated 31.5kA/25kA* for 3 Sec/
Short
circuit
current

* For Tertiary loading Equipment's fault level shall be 25kA for 3 Sec. For Other Switchyards shall be as specified in Section Project

□ Further Parameters of 52 kV System is also added □
Sectional Clearance of 66kV System is updated in line with Safety regulation of CEA The Contractor shall submit 4 (four) sets of All Engineering Documents

(drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports) through Online Document Review and Engineering Approval Management System(Herein after DREAMS) for the approval of the Employer. ~~The contractor shall also submit the softcopy of the above documents in addition to hardcopy~~

Approval Procedure

Note (2) All drawings should be submitted in **softcopy form DREAMS**, however further substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version as **supporting** documents in DREAMS. 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 as supporting document in DREAMS.	
11.	Clause 6.1.7	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 in the proposal, 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.	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 proposal 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.	
12.	Clause 6.2.4	Degree of Protection The degree of protection shall be in accordance with IS:13947(Part-I)/IEC-60947 (Part-I)/IS 12063/IEC-60529. Type test report for IP-55 or	Degree of Protection The degree of protection shall be in accordance with IS/IEC60947; IS/IEC60529 . Type test report of relevant Degree of Protection test shall be submitted for approval.	IS 13947 is superseded by IS/IEC 60947 IS 12063 is

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		higher degree of protection shall be submitted for approval.		superseded by IS/IEC 60529
13.	Clause 6.3.1	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, , 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 IEC requirement.	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.	
14.	Clause 9.2	The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in ENDCUSTOMER shall	The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in ENDCUSTOMER shall be applicable for all projects with similar requirement. The type tests conducted earlier should have	In line with CEA Guidelines for Validity of Type tests

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

	<p>be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by ENDCUSTOMER or representative authorized by ENDCUSTOMER or Utility or representative of accredited test lab.</p> <p>Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within last 10 (ten) years from the date of NOA. In case the test reports are of the test conducted earlier than 10 (ten) years from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer</p>	<p>either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by ENDCUSTOMER/representative authorized by ENDCUSTOMER/representative of Utility /representative of accredited test lab/ representative of NABCB certified agency shall also be acceptable.</p> <p>Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within the years specified below from the date of NOA. In case the test reports are of the test conducted earlier than the years specified below from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer.</p>																					
		<table><tr><th>S. No</th><th>Name of Equipment</th><th>Validity of type test(in years)</th></tr><tr><td>1</td><td>Power Transformer</td><td>5</td></tr><tr><td>2</td><td>LT Transformer</td><td>5</td></tr><tr><td>3</td><td>Shunt Reactor</td><td>5</td></tr><tr><td>4</td><td>OLTC</td><td>10</td></tr><tr><td>5</td><td>Bushing of Power Transformers/Reactors</td><td>7</td></tr><tr><td>5</td><td>Fittings and accessories for Power transformers &</td><td>10</td></tr></table>	S. No	Name of Equipment	Validity of type test(in years)	1	Power Transformer	5	2	LT Transformer	5	3	Shunt Reactor	5	4	OLTC	10	5	Bushing of Power Transformers/Reactors	7	5	Fittings and accessories for Power transformers &	10
S. No	Name of Equipment	Validity of type test(in years)																					
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

				Reactors		
			7	Circuit Breaker	10	
			8	Isolator	10	
			9	Lighting Arrester	10	
			10	Wave Trap	10	
			11	Instrument transformer	7	
			12	GIS & Hybrid GIS	10	
			13	LT Switchgear	10	
			14	Cable and associated accessories	10	
			15	Relays	7	
			16	Capacitors	10	
			17	Battery & Battery Charger	7	
			18	Conductor & Earth wire	10	
			19	Insulators (Porcelain/Glass)	10	
			20	Composite Insulators	5	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<table><tr><td>21</td><td>PLCC</td><td>5</td></tr></table> <p>Note</p> <p>For all other equipment's validity of type test shall be 10 years from date of NOA</p> <p>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, the type tests not carried out, same shall be carried out without additional cost implication to the Employer.</p> <p>The Contractor shall intimate the Employer the detailed program about the type test at least two (2) weeks in advance in case of domestic supplies & six weeks in advance in case of foreign supplies</p>	21	PLCC	5	
21	PLCC	5					
15.	Clause no. 9.5	The list of makes of various items, for which Type test reports are not required to be submitted are specified in Compendium of Vendors (COV).	The list of makes of various items, for which Type test reports are not required to be submitted are specified in Compendium of Vendors (COV) at Annex-J				
16.	Clause 12.2	The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above and 900 gm/sq.m for coastal area (30km from sea shore approximately) or as specified in Section-	The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above and 900 gm/sq.m for coastal area (30km from sea shore approximately if defined in Section Project) or as specified in Section-Project . For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For				
		Project. 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/sq.m minimum and 900 gm/sq.m for coastal area as specified in Section-Project	surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum and 900 gm/sq.m for coastal area as specified in Section-Project				
17.	Clause 12.3.2		Hot Phosphating shall be done for phosphating process under				

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		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	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																	
18.	Clause 12.3.6	<table><thead><tr><th>S.No</th><th>PIPE LINE</th><th>BASE COLOUR</th><th>BAND COLOUR</th></tr></thead><tbody><tr><td>1</td><td>Hydrant and Emulsifier system pipeline</td><td>Fire red</td><td></td></tr></tbody></table>	S.No	PIPE LINE	BASE COLOUR	BAND COLOUR	1	Hydrant and Emulsifier system pipeline	Fire red		<table><thead><tr><th>S.No</th><th>PIPE LINE</th><th>BASE COLOUR</th><th>BAND COLOUR</th></tr></thead><tbody><tr><td>1</td><td>Hydrant and Emulsifier system pipeline /NIFPS</td><td>Fire red</td><td></td></tr></tbody></table>	S.No	PIPE LINE	BASE COLOUR	BAND COLOUR	1	Hydrant and Emulsifier system pipeline /NIFPS	Fire red		
S.No	PIPE LINE	BASE COLOUR	BAND COLOUR																	
1	Hydrant and Emulsifier system pipeline	Fire red																		
S.No	PIPE LINE	BASE COLOUR	BAND COLOUR																	
1	Hydrant and Emulsifier system pipeline /NIFPS	Fire red																		
19.	Clause no. 12.3.8		Band colour is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band colour shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.	New Clause added																
20.	Clause No. 13.14		Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipments, NIFPS System ,	New Clause added																

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			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 BPS.															
21.	Clause no. 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.			New Clause added												
22.	Clause no. 16.2	The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.			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 metres.													
23.	Clause 17.1	<table><tr><td>S.No</td><td>Description</td><td>Material</td></tr><tr><td>a</td><td>For connecting ACSR conductors/AAC conductors/Aluminium tube</td><td>Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617</td></tr></table>	S.No	Description	Material	a	For connecting ACSR conductors/AAC conductors/Aluminium tube	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617	<table><tr><td>Sl. No.</td><td>Description</td><td>Materials</td></tr><tr><td></td><td></td><td></td></tr></table>			Sl. No.	Description	Materials				
S.No	Description	Material																
a	For connecting ACSR conductors/AAC conductors/Aluminium tube	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617																
Sl. No.	Description	Materials																

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		b	For connecting equipment terminals made of	Bimetallic connectors made from aluminum alloy casting, conforming	a)	For connecting ACSR conductors/AA C conductors/Aluminum tube	Aluminum alloy casting, conforming to designation A6 4600 of IS:617 and all test shall conform to IS:617		
			copper with ACSR conductors/AAC conductors/Aluminum tube	to designation A6 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617	b)	For connecting equipment terminals made of copper with ACSR conductors/AA C conductors/Aluminum tube	Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 4600 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617		
24.	Clause 17.11							minimum three	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>Clamps and connectors should be type tested on 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 once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable</p> <p>i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)</p> <p>ii) Short time current test</p> <p>iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]</p>	<p>Clamps and connectors should be type tested on samples as per IS:5561 & subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable</p> <p>i) Temperature rise test (maximum temperature rise allowed is 35°C $\frac{1}{2}$ and RIV</p> <p>ii) Short time current test iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]</p> <p>iv) Resistance test and tensile test Pullout strength</p> <p>v) Cantilever strength test on bus support clamps & connectors</p>	
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		iv) Resistance test and tensile test		
25.	Clause 18.1	All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS5039/IS-8623, IEC-60439, as applicable, and the clauses given below:	All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS 5039/IS 8623, IEC 60439 IS/IEC 61439-0 , as applicable, and the clauses given below:	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

26.	Clause 18.2	Control cabinets, junction boxes, Marshalling boxes, & terminal boxes shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 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 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.	<p>Control cabinets, junction boxes, Marshalling boxes & terminal boxes, Out door ACDB cum DCDB panels shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 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 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.</p> <p>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 to be also done on non-conducting sheet.</p> <p>For CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES FOR OUTDOOR EQUIPMENT Junction Box, wire should be as per IS or equivalent IEC with FRLS grade</p> <p>Machine laid PU Foam gasket may be permitted for use in Control Cabinets etc.</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

27.	Clause 18.4	Cabinet/boxes 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	Cabinet/boxes 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. Cabinet boxes with width more than 700 mm shall be double door double hinged with padlocking type.	
28.	Clause 18.13	The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS:13947 including application of 2KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test	The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS/IEC60947 including application of minimum 1KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test	
29.	Clause 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. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.	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. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

30.	Clause 20.14	All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.	-	Clause deleted
31.	Clause 21.3.2	All fuses shall be of HRC cartridge type	All fuses shall be of HRC cartridge type conforming to relevant IS	
		conforming to IS:9228 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	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	
32.	Clause 22.8	Tests In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS:2099 & IS:2544 & IS:5621.	-	Clause deleted

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

33.	Clause No. 22.10		<p>All switchgear/equipments, insulator strings, bushings, bus post insulators shall be designed for minimum creepage distance of 31mm/kV or 25mm/kV as mentioned against each substation in section project under “PHYSICAL AND OTHER PARAMETERS” Zinc coating for galvanized lattice and pipe structures, all ferrous parts of composite long rod insulators and earthing conductors shall not be less than 900 gm/sq-m irrespective of other values mentioned elsewhere in technical specification/drawings at substations where creepage distance is considered as 31mm/kV. In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creepage (31mm/kV) of the switchgear/equipments, insulator strings, bushings & bus post insulators etc., Design, supply & erection of such structures shall be in the scope of contractor against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipments.</p> <p>Silicon RTV coating:- Equipment/insulators (except equipments with polymer insulator) including mandatory spares being supplied at</p>	New Clause added
			substations where creepage distance is considered as 31mm/kV shall be with Silicon RTV coating. The price of RTV coating shall be included in the installation cost of respective equipment.	
34.	Clause No. 24	<p>TECHNICAL REQUIREMENT OF EQUIPMENTS</p> <p>Following equipment shall be offered from the 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.</p>	<p>24. TECHNICAL REQUIREMENT OF EQUIPMENTS</p> <p>24.1 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.</p>	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

35.	Clause 24.1	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 atleast two (2) years as on the date of NOA.	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 atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>(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</p> <p>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 NOA.</p> <p>Contractor shall furnish performance guarantee for an amount of 10% of the exworks cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.</p>	<p>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 NOA.</p> <p>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.</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

25.	Clause No. 24.2	Technical Requirement for 765kV class Transformer (i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number three phase Transformer of atleast 500 MVA capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These transformer(s) must have been in satisfactory operation# for atleast two	Technical Requirement for 765kV class Transformer (i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA, and the same transformer (s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>(2) years as on the date of NOA.</p> <p>(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</p> <p>a) 715kV or higher voltage class one (1) number three phase Transformer of at least 500 MVA capacity (or equivalent capacity in a bank of three (3) numbers single phase units) 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 NOA.</p> <p>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.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>(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</p> <p>a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.</p> <p>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.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10-3% 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</p>	
26.	Clause No. 24.3		24.3 Technical Requirement for 765kV class Reactor	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		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	
		(i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 715kV or higher voltage class one (1) number three phase Reactor of atleast 240 MVAR	higher voltage class one (1) number 1-phase Reactor of at least 110 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 36.7 MVAR and the same Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

	<p>capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>(ii) The Manufacturer must have designed, manufactured, tested & supplied 715kV or higher voltage class one (1) number three phase Transformer of atleast 500MVA capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA. And the manufacturer must have designed, manufactured, tested & supplied 345kV or higher voltage class one (1) number three phase Reactor of atleast 50MVAR capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Reactors must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(iii) Alternatively, the manufacturer, who have established manufacturing and testing</p>	<p style="text-align: center;">OR</p> <p>The Manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1 phase Transformer of at least 500 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 M or at least three (3) numbers 1 capacity of at least 16.7 MVAR and the same Transformer(s) & Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who manufacturing and testing facilities in India and not meeting stipulated in (i) above, can also be considered provided that</p> <p>a) 715 kV or higher voltage class either One (1) no. phase Reactor or 80 no. 1-phase Transformer of at least 166 MVA capacity manufactured in the above Indian works based on technology of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i)</p>	<p>capacity or at least</p> <p>VAR capacity</p> <p>s each having a</p> <p>ive established</p> <p>1- capacity or One (1)</p>
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

~~(iv) 715kV or higher voltage class one (1) number three phase Reactor of atleast 240MVAR capacity (or equivalent capacity in a bank of three (3) numbers single phase units) 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 NOA.~~

~~(v) 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.~~

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

c) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.

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.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

27.	Clause 24.4	24.4 Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer (i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied 400kV/220kV/132kV/110kV* or	24.4 Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer (i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>higher voltage class transformers. These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(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</p> <p>a) 220kV (applicable for supply of 400kV and 220kV class Transformer)/ 132kV (applicable for supply of 132kV & 110kV 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 NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology</p>	<table><tr><td>345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA</td><td>applicable for supply of 400kV class Transformer</td></tr><tr><td>220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA</td><td>applicable for supply of 220kV class Transformer</td></tr><tr><td>commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA</td><td>applicable for supply of 132kV class Transformer</td></tr></table> <p>These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p>	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	
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									

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		transfer / license to design, manufacture, test and supply	(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>400kV/220kV/132kV/110kV* transformer in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount of 10% of the exworks cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 220kV (applicable for supply of 400kV and 220kV 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 NOA.</p> <p>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/110kV* transformer in India, shall be submitted.</p> <p>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.</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

28.	Clause 24.5	24.5 Technical Requirement for 400kV, 220kV and 132kV class Reactor	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	(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested & supplied Reactor as per table below:	
		400kV/220kV/132kV* or higher voltage class. These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.	345kV or above class 3phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1phase Shunt Reactors, each having capacity of at least 16.7 MVAR	applicable for supply of 400kV class Reactors
		(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	220kV or above class 3phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1phase Shunt Reactors each having capacity of at least 6.67 MVAR	applicable for supply of 220kV class Transformer
			(ii)	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>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 as on the date of NOA.</p> <p>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</p>	<table><tr><td>132kV or above class 3phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1phase Shunt Reactors each having capacity of at least 5 MVAR</td><td>applicable for supply of 132kV class Transformer</td></tr></table> <p>These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated</p>	132kV or above class 3phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1phase Shunt Reactors each having capacity of at least 5 MVAR	applicable for supply of 132kV class Transformer	
132kV or above class 3phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1phase Shunt Reactors each having capacity of at least 5 MVAR	applicable for supply of 132kV class Transformer					

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>Reactor in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount of 10% of the exworks cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>in (i) above, can also be considered provided that</p> <p>a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.</p> <p>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.</p> <p>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.</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

29.	Clause 24.6	24.6 Technical Requirement for 400 kV Grade XLPE Power Cables	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	(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	
		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 NOA.	XLPE insulated cable which must be in operation for at least 2 (two) years as on the date of NOA.	
		(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that	(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	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 NOA. OR b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA. OR b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.	Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.	
30.	Clause 24.7	24.7 Technical Requirement for 220KV Grade XLPE Power Cables	24.7 Technical Requirement for 220KV, 132KV,110KV Grade XLPE Power Cables	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/132kV/110kV* or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(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</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/132kV/110kV* or higher grade XLPE insulated cable and which must be in satisfactory operation for atleast one (1) year as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/132kV/110kV* or higher grade XLPE insulated Cable as on the date of NOA.</p> <p>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			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 equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

31.	Clause 24.8	24.8 Technical Requirement for 132KV, 110kV, 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 atleast 5 (five) km of single core, 132KV/110kV/66kV* or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA. (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i)above, can also be considered provided that	24.8 Technical Requirement for 132KV, 110kV, 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 atleast 5 (five) km of single core, 132KV/110kV /66kV* or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA. 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 132KV/110kV /66kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		a) The manufacturer must have designed, manufactured, type tested and supplied 132KV/110kV/66kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.		
32.	Clause No. 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 atleast 100 Kms of 1.1kV grade PVC insulated control cables as on the originally scheduled date of bid opening. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA	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 atleast 100 Kms of 1.1kV grade PVC insulated control cables as on the originally scheduled date of bid opening the date of NOA . Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA	
33.	Clause No. 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 atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of	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 atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		1C x 150 Sq. mm or higher size as on the date of NOA.		
34.	Clause 24.15	24.15 Technical Requirements for LT	24.15 Technical Requirements for LT Transformer	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>Transformer</p> <p>i) The manufacturer, whose LT transformer(s) are offered, must have designed,manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 630kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>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</p> <p>a) At least 33kV class of 630 kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA.</p> <p>b) the 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 contract performance guarantee to be submitted by the contractor.</p>	<p>i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 630kVA 315kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>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 630 kVA 315kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA.</p> <p>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</p>	
35.	Clause 24.16	<p>24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)</p> <p>(i) The manufacturer whose</p>	<p>24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)</p>	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		Composite Long rod Insulator are	(i) The manufacturer whose Composite Long rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		<p>(ii) offered, must have designed, manufactured, tested and supplied Composite Long rod Insulator of 120KN or higher electromechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>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</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electromechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.</p>	<p>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 atleast two (2) years as on the date of NOA.</p> <p>(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</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.</p> <p>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.</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		Contractor shall furnish performance guarantee for an amount of 10% of the exworks cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor		
36.	Clause 24.19	24.19 Technical Requirement of Communication Equipment The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipments 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 NOA.	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 equipments 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 NOA	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

37.	Clause 24.20	24.20 Technical Requirement of “Indian Associate” for execution of on shore supply and services for 765 kV Transformer & Reactor package Indian associate must have erected at least two (2) or more circuit breaker equipped bays of 345 kV or above voltage level or at least two (2) nos. of 345 kV or above voltage class transformer/reactor; during last seven (7) years and above bays/transformer/reactors must be in satisfactory operation# as on the date of NOA	.	Clause Deleted
38.	Clause 24.20		24.20 Technical Requirement for 400kV GIS Equipment	New Clause added
			(i) The manufacturer whose 400kV GIS bays are offered must (ii) have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<p>[REDACTED], the manufacturer, who have established g and testing facilities in India and not equirement stipulated in (i) above, can also be ovided that</p> <p>a) [REDACTED] one no. 345kV or above voltage class GIS reaker bay@ must have been manufactured in e Indian works based on the technological of the Collaborator(s) and either supplied or d the above CB bay (as per IEC or equivalent) as on the date of NOA.</p> <p>b) [REDACTED] aborator(s) meets the requirements stipulated ove. A valid collaboration agreement for gy transfer / license to design, manufacture, supply 400kV or above voltage level GIS nt in India, shall be submitted.</p> <p>c) The [REDACTED] collaborator(s) shall furnish guarantee performance an amount of 3 % of the ex-works cost equipment(s) and this performance guarantee n addition to Contract Performance Guarantee mitted by the bidder.</p>	
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			<p>Note :- (**)</p> <p>Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

39.	Clause 25.0		<p>25.0 Technical Requirement of Sub-contractors:</p> <p>The subworks during last 7 years as on the last day of month previous to the one in which the sub-contractor is proposed to be engaged:</p> <p>a) Contractor must have either of the following experience of having successfully completed similar work of the following nature and value:</p> <p>b) Three similar works costing not less than the amount equal to 40% of the cost of the work to be sub-contracted.</p> <p style="text-align: center;">OR</p> <p>c) Two similar works costing not less than the amount equal to 50% of the cost of the work to be sub-contracted.</p> <p style="text-align: center;">OR</p> <p>One similar work costing not less than the amount equal to 70% of the cost of the work to be sub-contracted.</p> <p>1. Minimum Average Annual Turnover **(MAAT)</p>	New Clause added
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			<p>for best three years i.e. 36 months out of last five financial years of the sub-contractor should be.....:</p>	
		**		

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<p>Other Income.</p> <p>Note: [REDACTED] ue from operations/ Gross operating income as incorporated in [REDACTED] nt excluding [REDACTED]</p> <p>a) [REDACTED] milar [REDACTED] policy. [REDACTED] such [REDACTED] work. [REDACTED] ie [REDACTED] work shall mean the work which are of similar</p> <p>b) [REDACTED] selection of sub [REDACTED] ae work to be sub-contracted e.g. for the scope of civil work to [REDACTED] the following formula: [REDACTED] cted, the experience should be of civil work. [REDACTED] The aforesaid qualifying requirement shall however, [REDACTED] not be applicable for engaging labour as per extant [REDACTED]</p> <p>c) [REDACTED] The cost of the work to be sub-contracted shall be [REDACTED] considered as available in the Contract Agreement. [REDACTED] However, if the value is not available in the Contract [REDACTED] Agreement, the same shall be the estimated value for [REDACTED]</p> <p>d) [REDACTED] iteria is in addition to extant policy on -contractor as per WPPP, [REDACTED] Vol-II. [REDACTED]</p> <p>e) [REDACTED] The MAAT requirement shall be worked out basis [REDACTED]</p>	
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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<div>Minimum Annual Turnover (MAAT) = Cost of the work to be contractedx1.5/Completion period years**</div> <div>**The completion period shall be considered as 1 year even if the same is less than 1 year.</div>																
40.			<div>26.0 Technical Requirement of Sub-contractors of GIS Packages</div> <div>In case of GIS is supplied from Indian GIS manufacturer, the erection, testing & commissioning of GIS shall be executed either by the bidder himself or by the Subcontractor meeting the following technical requirement:</div> <div>The bidder/Subcontractor must have erected, tested and commissioned at least two (2) nos. GIS/AIS Circuit breaker equipped bays@ of voltage class** as specified below or higher in one (1) substation or switchyard during the last seven (7) years and these bays must be in satisfactory operation# as on the date of NOA.</div> <table><tr><td>S. no</td><td>Voltage class of GIS Package</td><td>Minimum Voltage class Circuit Breaker Equipped of Bay(**)</td></tr><tr><td>1</td><td>765kV & 400kV GIS</td><td>345kV</td></tr><tr><td>2</td><td>220kV</td><td>220kV</td></tr><tr><td>3</td><td>132kV</td><td>110kV</td></tr><tr><td>4</td><td>66kV</td><td>66kV</td></tr></table>	S. no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)	1	765kV & 400kV GIS	345kV	2	220kV	220kV	3	132kV	110kV	4	66kV	66kV	New Clause added
S. no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)																	
1	765kV & 400kV GIS	345kV																	
2	220kV	220kV																	
3	132kV	110kV																	
4	66kV	66kV																	

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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

			<p>Further, the sub-contractor shall also meet the requirement specified at Clause No. 25.0 of this section.</p> <p>Note:</p> <p>1. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing GIS means SF6 Gas insulated Switchgear. AIS Means Air satisfactory operation means certificate issued by the e operation without any adverse CTs.</p> <p>Insulated Switchgear.</p> <p>2. # Owner/Utility certifyi remark.</p>	
41.	Section GTR Rev 14 Annexure-A	Annex-A: Corona and Radio Interface Voltage(RIV) Test		Annexure updated
42.	Section GTR Rev 14 Para-1 at Annexure-B		<p>“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.”</p> <p>Seismic Calculations certified by NABL Labs shall also be acceptable</p>	Annexure updated

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

43.	Annexure-D	List of General Standard/Document for second advance		The Annexure is updated with incorporation of requirement for GIS & EHV cables (
				above 132kV)
44.	Annexure F	Assessment report from main Contractor for proposed sub vendors list of enclosure		The Annexure is updated
45.	Annexure-G	MOP & Inspection Level Requirement		The Annexure is updated
46.	Section GTR Rev 14 Annexure-H	Annex-H:RTV Silicon high voltage insulation coating(HVIC)		Annexure updated
47.	Annexure J		List of make for which type test reports are not required	The New Annexure is added
48.	Annexure K		List of Equipment's to be supplied from domestic manufacture only	The New annexure added

Note: The details mentioned in this annexure are only for the purpose of identification of changes in this revision of Technical Specification only, how ever details mentioned at respective clause shall be referred for execution purpose.

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

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

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

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

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ARORA

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by ANURAG
KRISHAN
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Annexure-G Rev 01

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

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

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

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

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

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

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

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

MANUFACTURING QUALITY PLAN

		Customer	Vendor's Code:	Item:	Q.P. No.	Valid From:
		POWERGRID			Rev. No. Date:	Valid Upto:
Code 1	Indicates place where testing is planned to be performed i.e. Inspection location		Code 2	Indicates who has to perform the tests i.e. Testing Agency		
A	At Equipment Manufacturer's works		J	The Equipment Manufacturer		
B	At Component Manufacturer's works		K	The Component Manufacturer		
C	At Authorized Distributor's place		L	The Third Party		
D	At Independent Lab		M	The Turnkey Contractor		
E	At Turn Key Contractor's location					
F	Not specified					
Code 3	Indicates who shall witness the tests i.e. Witnessing Agency		Code 4	Review of Test Reports/Certificates		
P	Component Manufacturer itself		W	By Equipment manufacturer during raw material/bought out component inspection.		
Q	Component Manufacturer and Equipment Manufacturer		X	By Contractor during product/process inspection		
R	Component Manufacturer, Equipment Manufacturer and Contractor		Y	By POWERGRID during product/process inspection		
S	Equipment Manufacturer itself		Z	By Contractor and/or POWERGRID during product/process inspection		
T	Equipment Manufacturer and Contractor					
U	Equipment Manufacturer and/or Contractor and POWERGRID					
V	Third Party itself					
Code 5	Whether specific approval of sub-vendor / Component make is envisaged?		Code 6	Whether test records required to be submitted after final inspection for issuance of CIP/MICC		
E	Envisaged		Y	Yes		
	Not Envisaged		N	No		

I Outdoor IP Based PTZ Camera:

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

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

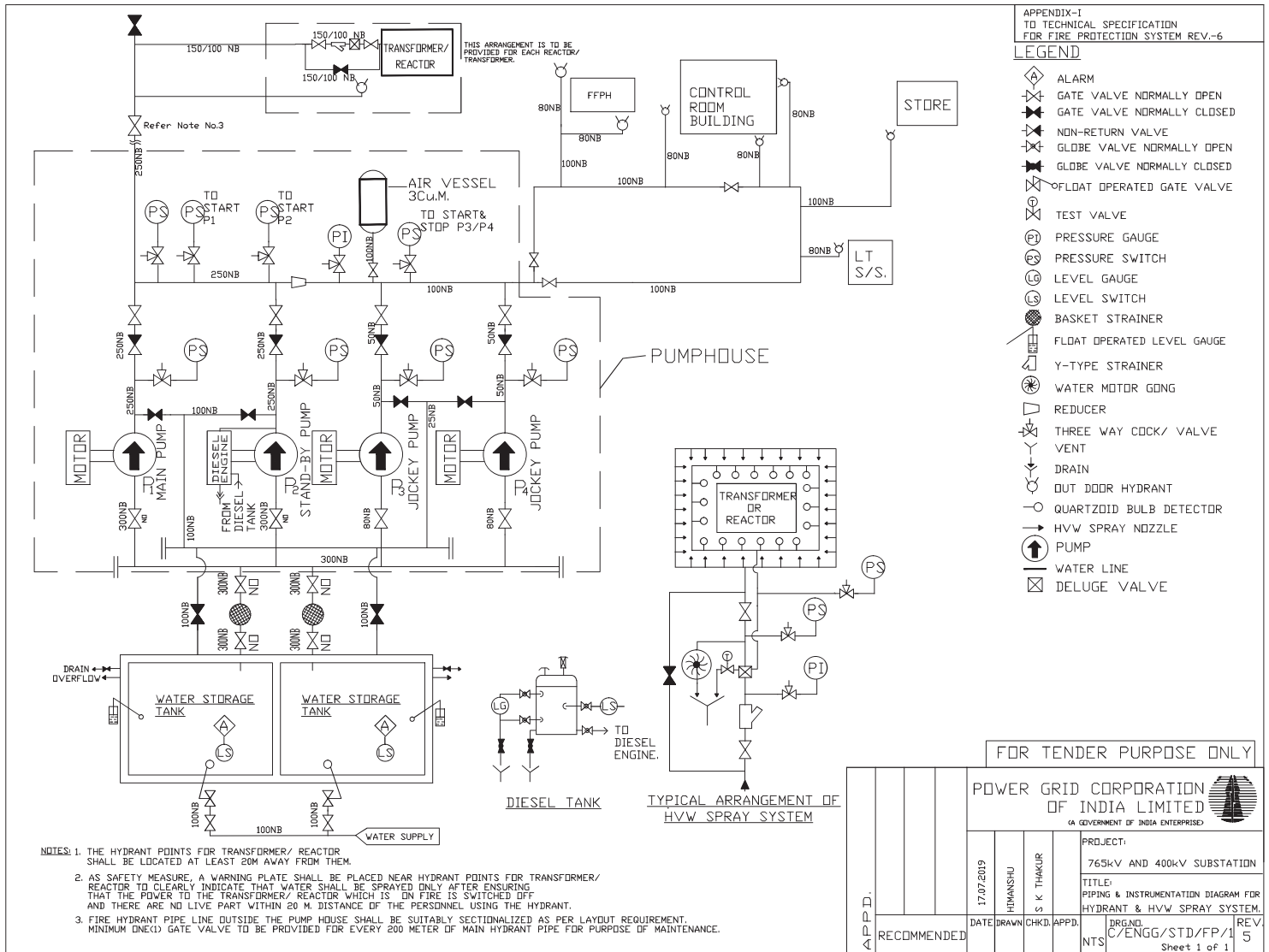
II. NVR (Network Video Recorder):

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

III. POE Switch:

S No	Item	Characteristics
1	Interfaces:	<ul style="list-style-type: none"> • 16 nos. 10/100/1000 BASE-T based POE ports • 02 nos. SFP ports
2	Standards	IEEE 802.3u, 802.3af/at, 802.3ab, 802.3az, 802.3x
3	Power Requirements	150W (30 W max per PoE port)
4	Switching Capacity	01 Gbps

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



TECHNICAL DATA SHEETS

DATA SHEET FOR DELUGE VALVE

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

METHODOLOGY FOR SIZING OF CONTROL CABLES

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

METHODOLOGY FOR SIZING OF POWER CABLES

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

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

AIR CONDITIONING & VENTILATION SYSTEM FOR GIS BUILDING

AIR CONDITIONING SYSTEM FOR GIS

1. GENERAL

- 1.1. This specification covers supply, installation, testing and commissioning and handing over to POWERGRID of Air conditioning system for the Local Control rooms & Maintenance Room in the GIS halls.
- 1.2. Air conditioning system shall be designed to maintain the inside DBT below 24oC. Bidder shall submit necessary design calculations for employer's approval.
- 1.3. At least 50% spare Air-Conditioning capacity shall be provided for Local Control rooms in the GIS halls.
- 1.4. Controllers shall be provided in Local Control room inside GIS hall for controlling and monitoring the AC units in these rooms as detailed in clause no.2.6.
- 1.5. Each Local Control room inside GIS hall shall be provided with temperature transducer to monitor the temperature of the Local Control rooms in the GIS halls. The Temperature transducer shall have the following specification.

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

2. AIR CONDITIONING SYSTEM REQUIREMENTS.

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

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

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

2.3. SCOPE

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

- 2.3.1.** Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.
- 2.3.2.** Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.
- 2.3.3.** Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.
- 2.3.4.** First charge of refrigerant and oil shall be supplied with the unit.
- 2.3.5.** GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.
- 2.3.6.** Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.
- 2.3.7.** All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.
- 2.3.8.** PVC drain piping from the indoor units upto the nearest drain point.
- 2.3.9.** Supply and erection of Power and control cable and earthing.
- 2.3.10.** MS Brackets for outdoor condensing units, condensers as required.

2.4. Technical specifications

2.4.1. Cassette type split AC units

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

- 2.4.1.1.** Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.
- 2.4.1.2.** Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode etc.
- 2.4.1.3.** Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have energy efficiency rating of 4 star as on the date of NOA.

2.4.2. High wall type split AC units.

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

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

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

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

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

- Standby units shall come in to operation automatically when the running main unit fails.
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:
 - a. Compressor On/OFF condition of each unit
 - b. Compressor failure of each unit
 - c. Power OFF to AC unit
 - d. High temperature in room

2.6. Warranty

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

Ventilation system for GIS Hall

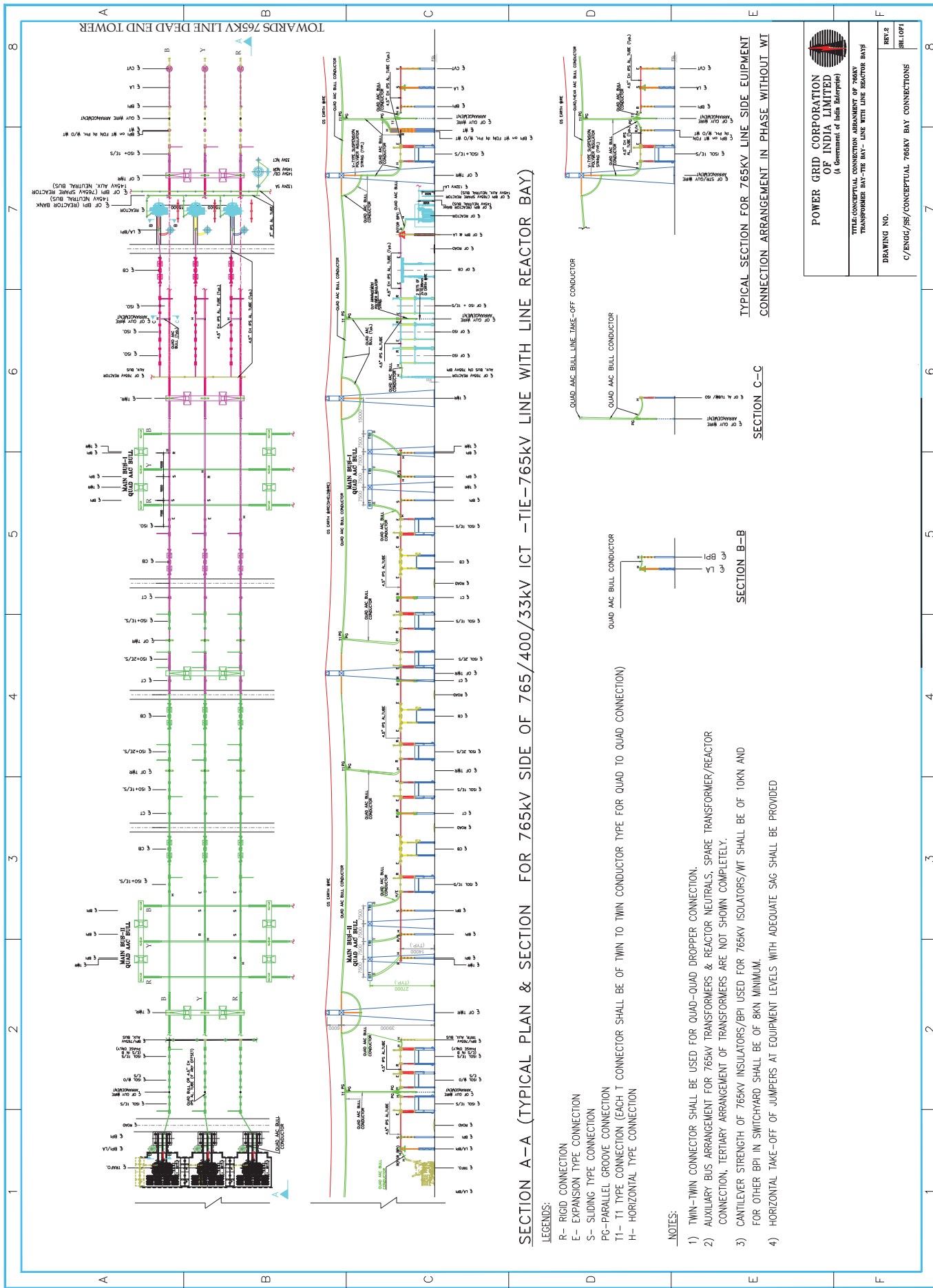
Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

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

1. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.
2. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

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

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



POWER GRID CORPORATION
OF INDIA LIMITED
(A Government of India Enterprise)

TITLE: CONCEPTUAL CONNECTION ARRANGEMENT OF 765KV
TRANSFORMER BAY-TIE LINE WITH LINE REACTOR BAYS

DRAWING NO. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS

REV.12

SRLOPI

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

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

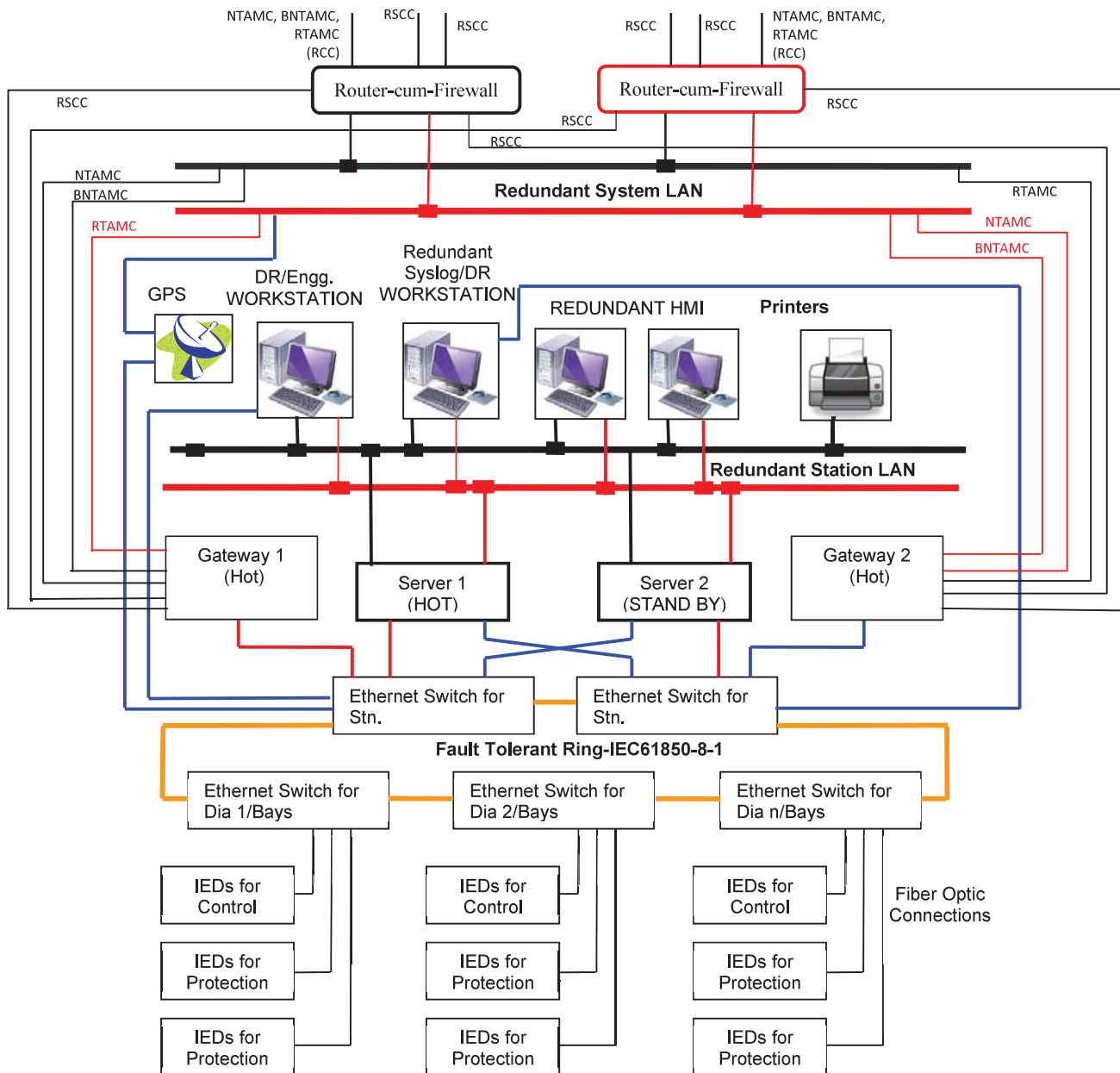
Voltage Level: 765kV, Fault Level: up to 50kA for 1 sec								
Bus Type	Height of Bus (from FGL)	Max Span	Bus Conductor Configuration	Ph-Ph Spacing	Normal Tension per phase	SCF per phase	Spacer Span	Applicable Wind Speed
Main Bus	27 Mtr	108 Mtr	Quad Bull	15Mtr	8T	9.75T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr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

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

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

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

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



Note:

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

SPECIFICATION FOR SWITCHES**Substation System LAN:**

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

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

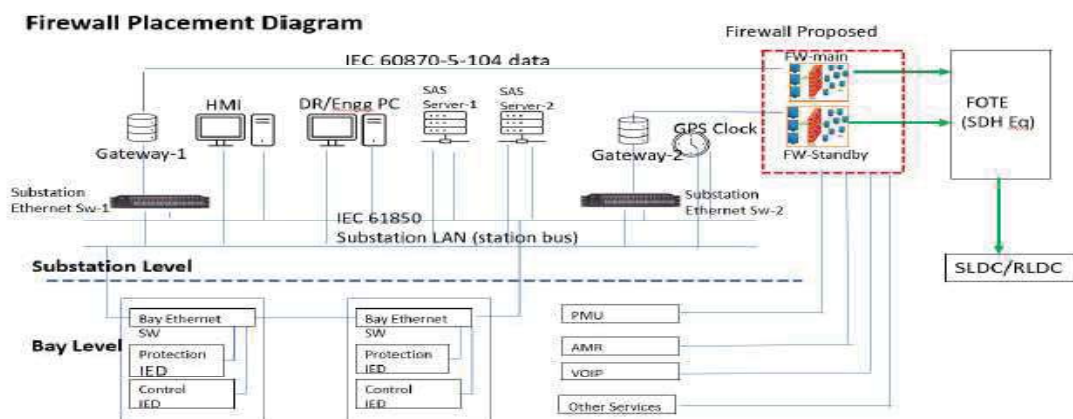
- (a) Compliance as per NERC-CIP-3, NERC-CIP-5, NERC-CIP-7 standard for cyber security
- (b) Support SNMPv3 (Full SNMP support including Traps)
- (c) Web based GUI or CLI based with HTTPS/HTTP and SSH/ Telnet support
- (d) Support for IPv4 and IPv6 switching simultaneously
- (e) Layer 3 Static routing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

Technical Specification for Next Generation Firewalls (NGFW)

1. NGFW shall have following features including but not limited to:
Encryption through IPSec VPN (Virtual Private Network), Deep Packet Inspection (DPI), Denial of service (DoS) & Distributed Denial of Service (DDoS) prevention, Port Block/ Allow, rules/ policies for block/allow, IP (Internet Protocol) & Media Access Control (MAC) spoofing protection, threat detection, Intrusion Prevention System (IPS), Anti-Virus, Anti-Spyware, Man In The Middle (MITM) attack prevention.
2. The proposed firewall shall be able to handle (alert, block or allow) unknown /unidentified applications e.g. unknown TCP & UDP packets. It shall have the provision to define application control list based on application group and/or list.
3. Firewall shall have feature and also have capability to update the definition/ Signatures of Anti-Virus online as well as offline. Firewall shall also be compatible to update the definitions/signatures through CMC. There shall be a defined process for security patching and firmware up-gradation. There shall be a feature to field validate firmware checksum. The same shall also be validated before using the OEM provided file/binary in the process of firmware up-gradation and security patching
4. Firewall shall have Management Console port to configure remotely.
5. Firewall shall be EMI/EMC compliant in Substation environment as per IEC 61850-3.
6. Firewall shall be rack mounted in existing standard equipment cabinets.
7. Firewall shall have support of SCADA applications (IEC-60870-5-104), IEC, PMU (IEEE C37.118), Sub-Station Automation System (IEC 61850), Ethernet and other substation environment protocols.
8. Client based Encryption/ VPN must support different Operating System platforms e.g. Windows, Linux & Mac.
9. The solution must have content and comprehensive file detection policies, blocking the files as function of their types, protocols and directions.
10. Firewall shall have logging facility as per standard logs/events format. Firewall shall have features to export the generated/stored logs/events in csv (Comma Separated Value) and also any other standard formats for offline usage, analysis and compliance. Firewall shall have suitable memory architecture and solution to store and be enable to export all logs/events for a period of last 90 days at any given time.
11. Firewall shall have features and be compatible with local as well as central authentication system (RADIUS, LDAP, or TACACS+) for user account and access right management. It shall also have Role Based User management feature.

12. Firewall shall have the capability to configure sufficient number of VLANs.
13. Firewall shall have the capability to support sufficient number of sessions.
14. Firewall shall have provision to configure multiple IP Sec VPNs, at least 100 nos., (one-to-many or many-to-one). Shall support redundant operation with a similar router after creation of all the IP Sec VPN. IPsec VPN shall be with encryption protocols as AES128, AES256 and hashing algorithms as MD5 and SHA1. IPsec VPN throughput shall be at least 300 Mbps.
15. Firewall shall be capable of SNMP v3 for monitoring from Network Management system. It shall also have SNMPv3 encrypted authentication and access security.
16. Firewall shall operate in Active/Passive or Active-Active mode with High Availability features like load balancing, failover for firewall and IPsec VPN without losing the session connectivity.
17. Firewall should have integrated traffic shaping (bandwidth, allocation, prioritisation, etc.) functionality.
18. Shall support simultaneous operation with both IPv4 and IPv6 traffic.
19. Firewall shall be compatible with SNTP/NTP or any other standards for clock synchronization.
20. Firewall shall have the features of port as well as MAC based security.
21. Firewall shall support exporting of logs to a centralized log management system (e.g. syslog) for security event and information management.
22. Firewall time shall be kept synchronised to official Indian Timekeeping agency, time.nplindia.org.
23. Firewall product shall be provided with all applicable updates at least until 36 months since the applicable date of product shipping to the concerned utility.

Figure-1



SPECIFICATION FOR DIGITAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cablesystem

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

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

1.2 Principle of operation

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

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

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

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

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

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

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

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

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

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

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

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

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

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

ii) **Specific power supply test**

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

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

- a) Security
- b) Dependability
- c) Jitter
- d) Recovery time
- e) Transmission time
- f) Alarm functions
- g) Temperature and Humidity tests (As per IEC 68-2)
 - Dry heat test (50°C for 8 hours)
 - Low temperature test (-5°C for 8 hours)
 - Damp heat test (40°C/95%RH for 8 hours)

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

60834-1 and the standards mentioned therein.

iv) **Relays**

- a) Impulse voltage withstand test as per clause 6.1 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686)
- b) High frequency disturbance test as per clause 5.2 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686).

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

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

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

1.4 Major technical Particulars

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

- i) Power supply 48V DC +15% /-20%
- ii) Number of commands 4 (four)
- iii) Operating time <7 ms
- iv) Back to back operate time without propagation delay ≤ 8 ms
- v) Interface to Protection relays

Input:	Contact Rating:
Rated voltage	: 250
volts DC	Maximum current rating: 5
amps	
Output:	Contact Rating:
Rated voltage	: 250 volts DC
Rated current	: 0.1 A DC
Other parameters :	As per IEC-255-0-20
- vi) Alarm contact

Rated voltage	: 250 volts DC
Rated current	: 0.1 A DC
Other parameters :	As per IEC-255- 0-20
- vii) Digital communication interface: G 703(E1

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

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

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

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

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

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

1.1 Technical requirements of major equipment of Visual Monitoring System.

- 1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.
- 1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.
- 1.1.3 The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using H 264/MPEG 4 or better standard. Mouse/Joystick-Keybaord controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.
- 1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more

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

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

1.2 System requirements:

- a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.
- b) All cameras may be connected through a suitable LAN which shall be able to perform in 765kV class sub-station environment without fail.
- c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
- d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.
- e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.
- f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.
- g) In order to optimize the memory, while recording, video shall be compressed using H 264/MPEG-4 or better standard and streamed over the IP network.
- h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.
- i) The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.
- j) System shall have provision of WAN connectivity for remote monitoring.
- k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:

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

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

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

- a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.
- b) The software should have inbuilt facility to store configuration of encoders and cameras.
- c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.
- d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.
- e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.
- f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.
- g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.
- h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.
- i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.
- j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

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

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

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

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

1.2.3 VMS Camera

- a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the POWERGRID premises as per the direction of Engineer-In-Charge
- b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit
- c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.
- d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.
- e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.
- f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux
- g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 765/400KV switchyard.
- h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password
- i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

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

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

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

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

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

1.2.4 PTZ-Keyboards

The features of PTZ shall include:

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

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

P R E F A C E

Salient changes made over previous TS -11

S No.	Ref Clause of Rev. 11A	Brief Description
1	1.1	Mention of "Approval of Employer for design/drawings" Insertion of order of precedence for Technical Specification, BIS code & CPWD specification
2	2.9.2.5	Signing and stamping of soil report by qualified Geotechnical engineer/ consultant
3	3.2.2, 3.4.2, 3.5.1	Layouts to be proposed by the contractor and approved by POWERGRID before execution
4	3.6	Weep holes/ gratings in boundary walls
5	3.6.3.7	"Cage" to be replaced with "design and drawing"
6	5.6 (a)	Supervision and safety of existing structures during dismantling works
7	8.0	Mentioning of IS 456-200 (latest) for RCC works.
8	8.1 & 8.2	Description of minor works for volumetric concreting. Clarity regarding Design mix added.
9	10.2	"Contractor" word added with vendor
10	10.2.6	RCC pedestal to finish at floor level
11	10.2.12	Clarity w.r.t floor finish of GIS hall
12	10.3.18	"working stress method" replaced by "limit state method" for PEB design
13	10.3.16	All design and detailing (including ductile) as per latest BIS standards
14	20.0	Reference of IS 1200 in case of ambiguity.

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P R E F A C E

Salient changes made over previous TS -10

S No.	Ref Clause of Rev. 11	Brief Description
1	2.9.2.4 (iv)	Liquefaction related in soil report
2	3.5.1	Provision of pre-cast cable trench
3	3.6	Specification of RCC frame brick masonry wall & stone masonry wall
4	3.6.4	structural steel angle supporting barbed wire/concertina coil over boundary wall shall be painted with epoxy paint
5	4.1, 4.2	"Sand" replaced with "fine aggregate"
6	5.0 & 20.1	Excavation in hard rock as separate item
7	5.6	Dismantling and demolishing works
8	8.2.1	Restriction of volumetric mix concrete
9	9.0	Reinforcement steel grade revised to Fe 500D
10	10.1.1	CRB shall be RCC structure at both AIS and GIS substations.
11	10.2.1	Partition sheet for extension works in GIS hall
12	10.2.2	Reference of BIS standard
13	10.3.9	Plinth level raised to 750 mm above FGL.
14	10.3.24	Air pressure maintaining measures.
15	10.7.1	Provision of pre-cast firewall
16	10.9	Aluminium door windows replaced with uPVC sections
17	10.9.1	PU coating over total area of GIS hall
18	10.11.2	Roof treatment through graded concrete.
19	10.12.7	Provision of "triple layered" polyethylene water storage tank
20	11.3.2	Min. value of Zn-Al coating in roof and wall sheeting changed to 150 gm/sqm
21	13.22	Provision of Seamless galvalume rolling shutter
22	20.12.2 & 20.12.3	Payment of miscellaneous structural steel for GIS equipment in GIS hall

SECTION: CIVIL WORKS

1.0 GENERAL

1.1 All civil works shall be carried out as per design/drawings provided by the Employer/ Contractor and as per these specification provided by the Employer. In case design/drawings are prepared by the contractor then these shall be approved by the employer before execution. In case any item is not covered under specification then the same shall be carried out as per CPWD specification /applicable BIS Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification/ BIS Standards, the same shall be executed as per manufacturer guidelines with the approval of employer. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the order of precedence shall be as under:

1.1.1 Technical specification,

1.1.2 BIS codes

1.1.3 CPWD specification.

The decision of engineer in charge in this regard shall be final and binding.

1.2 Wherever reference to CPWD/BIS Codes is made, it shall be to the latest edition/revision of the same, issued up to 7 days prior to the date of opening of this tender.

1.3 The Contractor shall arrange all labour, tools, equipment, materials, temporary works, constructional plant & machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Employer.

1.4 All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.

1.5 The Contractor shall execute the work as per the Field Quality Plan (FQP) which is available on POWERGRID website. All testing required shall be arranged by the Contractor at his own cost.

1.6 The bidder shall fully apprise himself of the prevailing conditions at the proposed site, Climatic conditions including monsoon patterns, local conditions and site specific parameters, soil parameters, availability of construction material and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

1.7 Unless leveling is in the scope of the bidder, fairly leveled site with single level/terraces with different levels/ gradual slope shall be handed over to the Contractor, in a phased manner. The finished ground level (FGL) with a tolerance of (+/-) 100mm shall be decided by the Employer. The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall provide all assistance in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

In case leveling is in the scope of bidder, FGL shall be decided by the employer.

1.8 Employer has standardized its technical specification for various items/ works. Specification for items which are covered in the scope and as defined in Section project & BPS shall only be referred.

1.9 The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification/ relevant BIS.

2.0 GEOTECHNICAL INVESTIGATION:

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the various structures safely and rationally.

A report to the effect shall be submitted by the Contractor for Employer's specific approval giving details regarding data proposed to be utilized for the design.

2.1 SCOPE:

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata starting from 0.5M from existing ground level for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Employer.

2.2 BORE HOLES:

- Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 15 meter depth into virgin soil or to refusal whichever occurs earlier shall be drilled. Total area of substation plot (including of Switchyard, Township and Future area) shall be considered for arriving at number of bore holes to be drilled. In any case number of boreholes shall not be less than five and shall not exceed twenty. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. In case rock is encountered within five meter from existing ground level, coring in all the boreholes shall be carried out up to 3 meter in rock.
- The Contractor shall carry out Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 0.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.
- The Contractor shall collect undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 0.5 m below ground level onwards in clayey strata.
- The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.
- All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.
- The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the laboratory without any damage or loss.
- The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

2.3 TRIAL PITS:

Trial pits shall be carried out at minimum one location per hectare as directed by the Employer. In case hard rock is encountered in trial pit, test need not be carried out. Total area of substation plot (including of Switchyard, Township and Future area) shall be considered for arriving at number of Trial Pit to be excavated. Minimum number of trial pits shall be five and maximum number shall be ten. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Employer. Undisturbed samples shall be taken from the trial pits as per the direction of the Employer.

2.4 ELECTRICAL RESISTIVITY TEST :

The resistivity of earth varies over a wide range depending on its moisture content, temperature, salt content and compactness. Therefore earth resistivity test shall be conducted preferably during the dry season in order to get conservative results.

2.4.1 TEST LOCATION

In the evaluation of earth resistivity for the substations, at least eight test directions shall be chosen from the centre of the substation to cover the entire area including the future area. The number of test points shall be as per approved drawing.

2.4.2 PRINCIPLE OF TEST

Wenner's four electrode method shall be used. In this method, four small electrodes shall be buried in four small holes in the earth along a straight line at equal intervals. A test current (I) by earth resistivity tester shall be passed between two outer electrodes and the voltage difference (V) between the two inner electrodes shall be measured. The test current (I) thus flowing into the earth, produces an electric field proportional to its density and to the resistivity of the soil. The voltage (V) measured between the inner electrodes is proportional to the field. Consequently, the resistivity will be proportional to the ratio of the voltage to current. Thus the resistivity shall be calculated from the following equation.

$$\rho_a = \frac{4\rho_a R}{1 + \frac{2a}{\rho(a^2 + 4b^2)} - \frac{a}{\rho(a^2 + b^2)}}$$

Where,

ρ_a is the apparent resistivity of the soil in Ω -m R is the measured resistance in Ω a is the distance between adjacent electrodes in metres b is the depth of the electrodes in m

2.4.3 TEST PROCEDURE

In the selected test point and chosen direction, four electrodes with insulated connecting wires shall be driven into the earth along a straight line of equal intervals (a). The depth of the electrodes in the earth shall be of the order of 15 cm to 20 cm. The megger shall be placed on a steady and approximately level base, the link between terminals P1 and C1 shall be opened and the four electrodes connected to the instrument terminals. An appropriate range on the instrument shall be selected to obtain clear readings avoiding the two ends of the scale as far as possible.

Resistivity shall be calculated by substituting the value of R in the above equation. The test shall be repeated in a chosen direction with a number of different electrode spacing, increasing from 2m to 50m preferably in the steps of 2, 5, 10, 15, 25 and 50m. When the spacing is increased gradually from low values, at a stage, it may be found that the resistivity reading is more or less constant irrespective of the increase in the electrode spacing. The resistivity for this spacing is noted and taken as the resistivity for that direction. In a similar

manner, resistivity for at least eight equally spaced directions from the centre of the test points shall be measured. These measurements shall be repeated for all test points.

NOTES:-

- i. Soil resistivity points shall preferably be one number in each 100mx100m grid and number of test points shall be such that the entire substation including the future area is covered.
- ii. Average resistivity value of all eight directions shall be considered for design of earthing system.
- iii. Soil resistivity measurement may be done in dry season. Small amount of water may be applied at electrodes for making proper contact between the electrodes and soil.

2.5 PLATE LOAD TEST

Plate load test shall be conducted to determine the bearing capacity, modulus of sub grade reaction and load/settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS: 1888. Modulus of sub grade reaction shall be conducted as per IS: 9214. Plate load test shall be conducted at two locations to be decided during detailed engineering at the proposed foundation depth below finished ground level for determining the bearing capacity.

Undisturbed tube samples shall be collected at 0.5 m and 2.5m depths from natural ground level for carrying out laboratory tests

The size of the pit in plate load test shall not be less than five times the plate size and shall be taken up to the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate.

The load shall be increased in stages. Under each loading stage, record of Time v/s Settlement shall be kept as specified in IS: 1888.

Backfilling of the pit shall be carried out as per the directions of the Employer. Unless otherwise specified the excavated soil shall be used for this purpose. In cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

2.6 WATER SAMPLE

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be

of sufficient quantity for chemical analysis to be carried out and shall be stored in air- tight containers.

2.7 BACK FILLING OF BORE HOLES

On completion of each hole, the Contractor shall backfill all bore holes as directed by the Employer. The backfill material can be the excavated material.

2.8 LABORATORY TEST

2.8.1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

2.8.2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid down in the relevant I.S. Codes.

The following laboratory tests shall be carried out i) Visual and Engineering Classification ii) Liquid limit, plastic limit and shrinkage limit for C-Ø soils. iii) Natural moisture content, bulk density and specific gravity. iv) Grain size distribution.

v) Swell pressure and free swell index determination.

vi) California bearing ratio. vii) Consolidated drained test with pore pressure measurement.

viii) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.

ix) In case of rock samples following tests shall also be conducted:

- Rock quality designation (RQD), RMR.
- UCC test.
- Point load index test.

2.9 TEST RESULTS AND REPORTS

2.9.1 The Contractor shall submit the detailed report in four (4) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the Contractor shall submit

draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of Employer.

2.9.2 The report shall include, but not limited to the following:-

2.9.2.1 A plan showing the locations of the exploration work i.e. bore holes, trial pits, Plate load test etc.

2.9.2.2 Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

2.9.2.3 Test results of field and laboratory tests shall be summarized strata wise as well as in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.

2.9.2.4 The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Employer. The observations and recommendations shall include but not limited to the following:

- i) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
- ii) Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
- iii) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 2.5.
- iv) Recommendation regarding liquefaction potential/characteristics of soil during ground shaking and possible remedies shall be provided.
- v) Recommendations regarding slope of excavations and dewatering schemes, if required.
- vi) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
- vii) If expansive soil is met with, recommendations on removal or detainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification of materials to be

used, construction method, equipments to be deployed etc. shall be furnished.
Illustrative diagram of a symbolic foundation showing details shall be furnished.

viii) Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.

ix) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given based on RMR value

2.9.2.5 All Geotechnical investigation reports must be signed and stamped by qualified Geotechnical engineer/ consultant even if they have been prepared by NABL accredited test labs.

3.0 STANDARD DRAWINGS:

- i) Standard drawings have been developed for Control Room Building, Switchyard Panel Room, Fire Fighting Pump House & Water Tank, Towers & Equipments Foundations, Transit Camp, Septic Tank & Soak Pit, Roads, Road Culverts & Rail Cum Road, Drains, Chain Link Fence & Switchyard Gate, Rain Water Harvesting by the Employer and are enclosed with the tender documents.
- ii) These drawings are good for construction and are also available on POWERGRID website. Additional prints if any required, can be downloaded from the website.
- iii) All tender drawings shall be read in conjunction with this specification. Discrepancy if any shall be brought to the notice of Employer prior to quote.
- iv) All foundation drawings including foundations for buildings, towers, equipments etc shall be released to the Contractor after award in a phased manner, after receiving the geotechnical investigation report.
- v) Drawings for transformer, reactor foundations and fire walls are not enclosed and shall be made available to the successful bidders by the Employer during detailed engineering. vi) In case the site conditions warrant any special type of foundations to be used, the same shall be designed and issued by the Employer to the Contractor during detailed engineering unless otherwise mentioned in section project.
- vii) Drawings for any non-standard tower or equipment and their foundation, if required, shall be designed by the Employer and made available to the Contractor during detailed Engineering unless otherwise mentioned in section project.
- viii) Drawings that have been mentioned and to be issued by the Employer to the Contractor during detailed Engineering shall be made available to the Contractor as per the agreed work schedule finalized after award.
- ix) Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

3.1 ROADS, ROAD CULVERTS AND RAIL CUM ROAD:

- 3.1.1 The construction drawings showing section detail for road, culverts as well as rail cum road are enclosed with the tender documents. The layout of roads shall be as per approved general arrangement drawing. Types of the roads in the scope of contract shall be either of RCC or bituminous road as indicated in the GA drawing or in Bid Price Schedule.
- 3.1.2 The width of the road shall be either 5.5m wide or 3.75m as indicated in the GA drawing. Type of pavement either rigid pavement (RCC Road) or flexible pavement (Bituminous Road) shall be as per tender documents.
- 3.1.3 The type & location of culverts i.e. the number and diameter of Hume pipes shall be as decided during detailed engineering. The invert level of Hume pipes of culverts shall match with the invert level of drain meeting the culvert.
- 3.1.4 100mm diameter RCC Hume pipe (NP-3) shall be provided across the road at every 100M interval along the road. In case NP3 pipe is not available, vendor may provide 100 dia UPVC pipe encased with 75 mm thk. concrete 1:2:4 around without any financial implication to POWERGRID.
- 3.1.5 Road within the switchyard area should have shoulder of 600mm wide on either sides of road. Shoulder shall be smooth finished with well compacted 75mm thick PCC 1:4:8. The road leading to control room building and the roads outside switchyard fence area shall be provided with kerb stone and interlocking tiles on shoulder. Width of shoulder shall be 1.75m in case of 5.5m wide road and 1.3m in case of 3.75m wide road.
- 3.1.6 The shoulder of the road in case of substation extension shall match with the shoulder of the existing road in all respect.
- 3.1.7 Road leading towards the area of Autotransformer/Reactor shall be as short as possible. Road layouts shall be prepared with adequate turning radius, so that easy movement of vehicles is possible. Roads which are to be used for carrying transformers / reactors shall be provided with turning radius preferably 19.5M or more but not less than 16.5M. Turning radius of other roads may be decided at site depending on layout constraints
- 3.1.8 Contractor may use WMM instead of WBM with prior approval of employer without any additional financial implication to POWERGRID. Guidelines of IRC: 109-1997 shall be followed for Wet Mix Macadam (WMM) only. However, measurement of road shall be done as specified elsewhere in this specification.
- 3.1.9 In case of rigid pavements, RCC shall be laid and finished with screed board, vibration, vacuum dewatering process etc.

3.2 DRAINS:

- 3.2.1 The construction drawing for the section of drain is enclosed with the tender documents.
- 3.2.2 The Contractor shall propose an overall drainage layout for the new sub-station or extension of substation during detailed engineering considering the site conditions which is to be approved by POWERGRID before execution. The type of drains used shall be of the sections standardized and indicated in the drawings enclosed with the tender documents.

3.3 CHAIN LINK FENCING AND SWITCHYARD GATE:

- 3.3.1 Fencing and Gate shall be constructed as per drawing attached with tender documents and are also available on POWERGRID website.
- 3.3.2 Fencing and Gate shall be provided at the locations shown in approved general arrangement drawing. Separate gate shall be provided for men and equipment. Fence shall also be provided for the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.
- 3.3.3 Chain link of galvanized fence fabric with 3.15mm dia wire and 75mm mesh size conforming to IS: 2721 shall be used. MS tube used shall be of grade YST210 and conform to IS: 1161. All other structural steel shall conform to IS: 2062.
- 3.3.4 The whole assembly of tubular post and frame of panels shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per square meter. In case the substation is located within 30km from sea coast, the zinc coating shall be 900gm per square meter. The purity of zinc shall be 99.95% as per IS: 209.
- 3.3.5 The gate shall be made of medium duty M.S. pipe of grade YST210 and conform to IS: 1161 with welded joints. The main frame (outer frame) of the gate shall be made of 40mm nominal bore pipe and vertical pipes of 15mm nominal bore @ 125mm spacing (maximum) shall be welded with the main frame. Gate shall be painted with one coat of approved steel primer and two or more coats of synthetic enamel paint to give an even shade.

3.4 RAIN WATER HARVESTING:

- 3.4.1 In addition to drainage of rainwater, the Contractor shall make arrangement for rainwater harvesting also. A drawing showing details of recharge structure for rainwater harvesting is enclosed with tender document and is also available on POWERGRID website.

- 3.4.2 Rainwater harvesting shall be done by providing recharge structures with bore wells. The contractor shall propose location of recharge structures within the sub-station considering the site conditions which is to be approved by POWERGRID before execution. Branch drains from the main drain carrying rainwater from entire switchyard shall be connected to the recharge structures.

3.5 CABLE TRENCHES:

- 3.5.1 The construction drawings of cable trenches, cable trench crossing road and sump are enclosed with tender documents. The construction of cable trenches shall be cast in situ type or pre cast RCC as per drawings and meeting the technical specification. The Contractor shall propose an overall cable trench layout for the substation during detailed engineering which is to be approved by POWERGRID before execution.
- 3.5.2 The layout should show type of cable trench, longitudinal slope and invert level calculated considering future extensions also. The types of cable trench shall be of the section indicated in the drawings enclosed with the tender documents and are also available on POWERGRID website.

3.6 BOUNDARY WALL

Boundary wall shall be brick masonry wall with RCC frame or Stone masonry wall or Pre cast RCC wall. The construction drawing of the boundary wall applicable is enclosed with tender document. All walls shall have adequate weep holes/ gratings as per drawing/ as per site conditions for the drainage of water. The layout shall be as per approved layout drawing during detail engineering.

3.6.1 Brick masonry wall with RCC frame:

Boundary wall shall consist of frame of RCC column and foundation at regular intervals connected through plinth beam and supporting 230 thick brick masonry. Details such as height, column spacing, structural details, fencing/grating works, plastering/ painting, etc. shall be as per tender/construction drawing.

3.6.2 Stone masonry wall:

Boundary wall shall be Random Rubble masonry wall and coursed rubble masonry (for front portion). The wall thickness shall be 350 thk and foundation, height, fencing shall be as per tender/construction drawing.

3.6.3 Pre cast boundary wall:

- 3.6.3.1 Pre-cast reinforced concrete units such as columns, posts, wall panels etc. shall be of grade M-25 Design Mix. Mix design concrete should be well proportioned, mixed, placed and thoroughly compacted by mechanical/platform/form vibrators to give a dense concrete free from voids and honey combing. Fly ash conforming to grade-I of IS: 3812 (Part-1) may be used as part replacement of OPC as per IS: 456. Uniform blending with cement to be ensured in accordance with clauses 5.2 and 5.2.1 of IS: 456 -2000. Admixtures may be used

with the approval of the engineer-in-charge. However use of any admixture containing chlorides in any form is prohibited. No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS: 9103 and the test results are approved by the Engineer-in-Charge.

3.6.3.2 The forms/ moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as angle for concertina coils, hooks and forming of notches and holes.

3.6.3.3 The contractor may pre-cast the units on cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be cast in one operation.

3.6.3.4 Pre-cast articles shall have a dense surface finish showing no coarse aggregate and shall not have cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angles of the pre-cast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. Arises shall be clean and sharp except those specified or shown to be rounded. Gaps if any noticed during installation shall be finished with 1:3cement Mortar. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.

3.6.3.5 The pre-cast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled. Date of casting shall be marked on the surface which should not be visible after installation.

3.6.3.6 The exposed surfaces of walls & columns shall be painted with water proofing cement paint of approved shade to give an even shade as per BOQ item.

3.6.3.7 Reinforcement as per approved design drawing shall be placed inside the mould in such a way as to fulfill the minimum cover requirement or as per the drawing. Concrete shall then be poured in middle and the sides and compacted with a plate vibrator (platform/table/surface vibrator).

3.6.3.8 Each Pre-cast unit shall have marking like; date of manufacturing and identification number. Units without marking shall not be accepted.

3.6.3.9 The mould sizes shall satisfy the following dimensional tolerances:

S.No.	DIMENSION	TOLERANCE
1	Length	±4 mm
2	Width	±2 mm
3	Depth	±2 mm

3.6.3.10 Contractor shall make his own arrangement for curing by making suitable size pond for curing as directed by Engineer-in-charge. After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. In hot & arid regions, the minimum curing period shall be 14 days.

OR

Pre-cast units shall be stacked against a vertical support in nearly vertical position and cured for at least two weeks by sprinkling water. If necessary, low pressure steam curing may be employed. It shall further be air cured for another two weeks before it can be used for construction. During initial stages of hardening, the Pre-cast units shall be adequately protected from shocks as well as harmful effects of frost, sunshine, drying winds and cold.

3.6.3.11 SAMPLING

- All Pre-cast units (viz. planks and columns) of the same size, manufactured from similar materials and under similar conditions of production shall be grouped together to constitute a lot.
- Five units shall be selected at random out of a lot consisting of 300 units or less. For lots bigger than 300 units, 5 units shall be selected for every additional 300 units or part thereof.
- The units shall be selected from the lot at random. In order to ensure randomness of selection, procedure given in IS: 4905-1968 may be followed. The sampling procedure may be modified, if the Engineer-In-Charge desires so.

3.6.3.13 DIMENSIONAL TOLERANCES

Pre-cast units manufactured in accordance with the drawings/specifications shall be required to satisfy following dimensional tolerances:

S.No.	DIMENSION	TOLERANCE
1	Length	±5 mm
2	Width	±3 mm
3	Thickness	±2 mm
4	Bow (Deviation from intended line or plane)	±2 mm
5	Twist (Distance of any corner from the plane containing other three corners)	1 mm

If four out of the five samples satisfy the shape (as per the drawing) and dimensional requirements as tabulated above, the lot represented by the sample shall be deemed to have passed the dimensional requirements.

3.6.3.14 HANDLING, STORAGE AND DELIVERY

- Pre-cast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged.
- Pre-cast units shall be transported to the site by suitable means as approved by the Engineer-In-Charge. Care shall be taken to ensure that no damage occurs during transportation.
- In case the units are to be transported in trolleys, the overhang of the units from the trolley shall not be more than one-fifth of length of the Pre-cast unit.
- For lifting/handling the units, rope slings shall be used at locations where lifting hooks have been provided. The units shall be lifted manually or with the help of chain pulley blocks or mechanically with a hoist or a crane. The Pre-cast units shall be handled and transported in nearly vertical position as far as possible and these should be supported only near the edges.
- Any defect/breakage arising during transportation, due to mishandling or due to faulty storage practice shall be the sole responsibility of the Manufacturer/Supplier/Agency.

3.6.3.15 ERECTION

- Precast concrete columns and wall panel shall be placed in truly vertical position with the aid of a compatible light crane/manually/by suitable means.
- For erection, panels are handled by means of lifting devices/manually to set into columns wedge. Panels may be carefully placed in successive horizontal position by means of temporary wooden wedges placed at the junction of the two adjacent panels during construction and which shall be removed after proper placement of panels.
- After placement of wall panels, gaps if any between the wall panels shall be filled with 1:3 cement mortar and shall be finished before taking up of painting. No extra payment shall be made for filling of joints with cement mortar.
- Pre-cast units shall be erected in such a manner that no part is overstressed or damaged due to faulty erection.
- Any defect/breakage occurred during erection shall be the sole responsibility of the Agency/Manufacturer/Supplier and such units shall not be accepted for use in construction.

3.6.3.16 MISCELLANEOUS

The work to be performed under this specification shall include providing all labour, supervision, materials, storages, inventories, all enabling works like scaffolding, watch and ward for the works, power, fuel, construction equipment, water, tools and plants, transportation, all taxes and duties, all labour welfare and safety measures, complete and all other incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the drawings and specifications, inspection and testing standards and field quality control and testing as given in the tender documents and the complete execution of the works.

Any technical clarifications required regarding the drawings/specifications during the progress of works shall be obtained from the Engineer-in-Charge.

Employer reserves the right to inspect all the material before dispatch.

3.6.4 All structural steel angle for supporting barbed wire/concertina coil shall be painted with epoxy paint of approved brand and colour shade.

4.0 STONE SPREADING AND ANTI-WEED TREATMENT

4.1 The layout of the area, where anti-weed treatment and stone spreading is to be done, shall be developed by the Contractor during detailed engineering and the same shall be submitted to the employer for approval. The Contractor shall arrange all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Employer.

4.2 Stone spreading over cement concrete layer shall be done in the areas of the switchyard under present scope of work. The cement concrete layer shall also be provided in future areas within the fenced area. However the stone spreading in future areas shall be provided in case step potential without stone layer is not well within safe limits.

4.3 The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Employer.

4.4 The material to be used for stone filling/site surfacing shall be stone aggregate of 40mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970. Hardness, flakiness shall be as required for wearing courses are given below:

- i) Sieve Analysis limits (Gradation) (IS : 383 – Table – 2)

Sieve Size	% passing by weight
63mm	100
40mm	85-100
20mm	0-20
10mm	0-5
- ii) Hardness : Abrasion value (IS:2386 Part-IV) – not more than 40% Impact value (IS: 2386 Part-IV) – not more than 30%.
- iii) Flakiness Index : As per IS: 2386 Part – I maximum value is 25%.
- iv) Frequency of test shall be conducted for sieve analysis, Hardness & Flakiness index as per latest SFQP available on POWERGRID website.

4.5 After all the structures/equipments are erected, antiweed treatment shall be applied in the switchyard where ever cement concrete is to be done and the area shall be thoroughly de-

weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used.

- 4.6 The antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the Contractor in a test area of 10MX10M (appx) and shall be sprinkled with water at least once in the afternoon every day after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – in- charge. The final approval shall be given by Engineer – in –charge based on the results.
- 4.7 Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.
- 4.8 After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-charge. The sub grade shall be consolidated by using half ton roller/surface vibrator with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.
- 4.9 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand rammer, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling / compaction.
- 4.10 The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.
- 4.11 Over the prepared sub grade, 75mm thick base layer of cement concrete in 1:5:10 (1 cement: 5 fine aggregate: 10 burnt brick aggregate 40mm nominal size) shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. The Contractor shall have option to use graded stone aggregate 40mm nominal size in place of brick aggregate without any extra cost to employer. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain.
- 4.12 The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of base layer of cement concrete in 1:5:10. A layer of cement slurry of mix 1:6 (1cement: 6 fine aggregate) shall be laid uniformly over cement

concrete layer. The cement consumption for cement slurry shall not be less than 150 kg for every 100 sq.m.

- 4.13 A final layer of 100mm thickness of stone aggregate of 40mm nominal size (conforming to clause 5.2.1) shall be spread uniformly over cement concrete layer after curing is complete.

5.0 EXCAVATION AND BACKFILL OF FOUNDATIONS:

Excavation for foundations shall be in accordance with CPWD Specification/ the relevant BIS code. Excavation shall include removal of all materials of whatever nature at all depth and whether wet or dry necessary for the construction of foundations. The bottom of excavation shall be leveled both longitudinally and transversely unless otherwise mentioned in the drawings or as directed by Engineer-in-charge. Excavation shall be measured as classified under:-

- a) Excavation in all kind of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
- b) Excavation in hard rock (required blasting)

- 5.1 If required the sides of excavations should be supported in such a way as is necessary to secure these from falling in, and the shoring, if required, shall be provided and maintained in position as long as necessary. No extra payment shall be made for shoring.

- 5.2 Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, The excavation shall be kept free from water:-

- ☐ When concrete and/or masonry works are in progress and till they come above the natural water level
- ☐ Till the Employer considers that the concrete/ mortar is sufficiently set.

No extra payment shall be made for dewatering.

- 5.3 Material unsuitable for foundations shall be removed and replaced by suitable fill material as per specification and to be approved by the Employer.

- 5.4 Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted. Requirements regarding density / tests of backfilled earth shall be as specified in Field Quality Plan. The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC (optimum moisture content). Cohesion less material sub-grade shall be compacted to 70% relative density (minimum).

5.5 If, excavated material is not suitable or not required for backfill, it shall be disposed off in areas as directed by Employer up to a maximum lead of 2 km from the substation boundary.

5.6 DISMANTLING & DEMOLISHING WORKS

- a. The scope of work includes dismantling of existing R.C.C. works at all levels (in foundations or super structures) either manually or by mechanical means including disposal of steel bars and unserviceable material as per direction of Engineer – in-charge. The work of dismantling of RCC works shall be measured in cu. m. Dismantling work must be carried out very carefully under strict close supervision to ensure structural stability of the remaining and/or adjoining/ abutting structure.
- b. The scope of work includes Demolishing/dismantling of existing chain link fencing either manually or by mechanical means including disposal of unserviceable material as per direction of Engineer – in-charge. The work of dismantling/demolishing of existing chain link fencing shall be measured in running meter.

5.7 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION:

5.7.1 The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

5.7.2 The filling shall be done in accordance with clause 4.10 of IS: 1080. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the Employer.

5.7.3 Cohesive Non Swelling (CNS) soil, if required, for filling under / around the foundations, cable trenches, drains, roads etc shall confirm to IS: 9451: 1994 reaffirmed 2004

6.0 CEMENT:

6.1 The type of cements which can be used are Portland Pozzolana cement (conforming to IS:1489), Ordinary Portland cement (conforming to IS:269 or IS:8112 or IS:12269), and Portland Slag cement. (Conforming to IS: 455). Cement shall be arranged by contractor.

6.2 Generally PPC type shall be used for concrete work. However depending on availability, OPC may also be used without any additional financial implication to POWERGRID.

6.3 Extra care for curing shall be taken for concrete made with OPC 53 grade & PPC.

6.4 Extra care for removing form work shall be taken, when PPC is used.

- 6.5 Portland Slag Cement has low heat of hydration and is relatively better resistant to soils and water containing excessive amount of sulphates of alkali metals, alumina and iron, as well as to acidic waters. Hence it can be specifically allowed for above conditions with prior approval of EIC.

7.0 CHEMICAL ADMIXTURES & ADDITIVES

- 7.1 Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.
- 7.2 It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect. The amount of admixture added to mix shall be recorded in the production record by the producer.
- 7.3 Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.
- 7.4 When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

8.0 REINFORCED CONCRETE CEMENT (RCC):

All RCC work including material properties, proportioning, batching, mixing, transporting, pouring, compacting, finishing, curing, sampling, testing, acceptance criterion etc. shall be as per IS : 456-2000 (or latest)

8.1 DESIGN MIX CONCRETE

- 8.1.1 For new substations and extensions except minor works, Reinforced cement concrete shall be M-25 design mix conforming to IS: 456. IS: 10262 shall be followed for mix proportioning. The minor work may be defined as any work involving less than 3.0 cum of concrete in a single day of concreting at one particular construction site .
- 8.1.2 Design mix concrete may be procured from approved RMC plant as per latest IS: 4926 or may be prepared by using a portable/mini/compact weigh batch plant conforming to latest IS: 4925

- 8.1.3 As per provisions of IS: 456, fly ash conforming to grade I of IS: 3812 (part-1) may be used as part replacement of cement, when OPC cement is used for concrete works. Uniform blending with cement is to be ensured.

8.2 VOLUMETRIC MIX CONCRETE

- 8.2.1 Use of volumetric mix concrete shall be restricted to minor works only (as per clause 8.1.1) with approval of engineer incharge. In such cases reinforced cement concrete shall be of volumetric mix 1:1.5:3 (1 cement: 1.5 coarse sand: 3 well graded stone aggregate 20mm nominal size) conforming to CPWD specifications. Volumetric mix 1:1.5:3 shall be considered equivalent to M-20.
- 8.2.2 In case of volumetric mixes, Standard measuring boxes of 35cmX40cmX25cm (35 liters capacity as per CPWD) shall be used for measuring fine and coarse aggregates.
- 8.2.3 However, full 50 kg of OPC/PPC/Slag cement shall be directly unloaded into the mixer hopper to ensure that cement consumption is 400kg per cum of 1:1.5:3 concrete irrespective of different types of cements with different densities.
- 8.2.4 The cement consumption shall be as per DSR (CPWD) for other grades of concretes provided as volumetric concrete in the BPS.
- 8.2.5 For volumetric mix concretes, the cement used may be generally PPC type, however concrete may be prepared with OPC also, without any financial implication to POWERGRID.

9.0 REINFORCEMENT STEEL:

Reinforcement steel shall be thermo mechanically treated (TMT) or HYSD reinforcement bars of grade Fe 500D conforming to IS: 1786. Reinforcement shall be arranged by contractor.

10.0 DRAWINGS AND DESIGN TO BE DEVELOPED BY CONTRACTOR / EMPLOYER DURING DETAILED ENGINEERING:

The following clauses are applicable for the design and drawings which are to be developed during detailed engineering either by contractor/ vendor or by employer as per section project.

10.1 CONTROL ROOM BUILDING:

- 10.1.1 For AIS Substations: Control room building shall be of RCC framed structure & brickwork (Conventional).
For GIS Substations: Control room building shall be of RCC framed structure with brickwork; however its alignment shall be in line with GIS hall & may/may not be attached to GIS hall as per detail engineering.
- 10.1.2 In case of extension of Control room building, the same shall be matched with existing building, whether it is PEB or Conventional.
- 10.1.3 All walls shall be of non-load bearing Minimum wall thickness of full brick with 1:6 cement sand mortar. Partition walls in toilets and pantry can be half brick walls with 1:4 cement sand mortar and two nos. 6mm dia MS bars at every third course. CPWD specifications shall be followed for brick masonry work.
- 10.1.4 Partitions, if any required shall be made of powder coated aluminium frame (minimum thickness of powder coating is 50 micron) provided with minimum 5.5mm thick clear glass or pre-laminated board depending upon the location of partition.
- 10.1.5 The details of doors and windows of the control room building shall be as per finish schedule Table-1.
- 10.1.6 IS approved or ISI Marked PVC electrical conduits of shall be provided as per the requirement of electrical installations including its accessories, junction boxes/surfaces boxes, fan boxes etc. Areas where false ceiling is provided electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area. In rest areas conduits & junction boxes, fan boxes etc. shall be concealed.
- 10.1.7 Contractor shall develop conduit layout drawing based on electrical illumination & Electrical installation drawings approved by POWERGRID. For control Room conference Hall/Admin Hall conduits are also to be provided below floor tiles for extending power supply/internet cables to Conference table users/ Admin Cubicles.
- 10.1.8 The plinth area of Control Room Building either PEB or conventional shall be as per respective items of BPS. The calculation of plinth area shall be as per IS:3861-2002. It shall comprise of following, to meet the functional requirement:
- Control room, ACDB & DCDB room, Battery room, Electrical lab, Telecom Room, InCharge Room with attached toilet, Administrative area, Pantry, Lobby, Passage, toilet, shafts etc.
 - Portico in case of RCC Building / 3m wide canopy in case of PEB ☐ One toilet should be disabled friendly.

10.1.9 The area for above provisions shall be suitably decided by bidder during detailed engineering stage in consultation with employer.

10.1.10 Control room building shall be so designed that most of the area of switchyard is visible from control room.

10.1.11 Open cable trenches in the building shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of epoxy paint as per item 13.52 of DSR' 2014 over a coat of steel primer.

10.1.12 The isometric view of the CRB with local aesthetic and best industry practices shall be submitted by vendors for approval of POWERGRID. Three alternatives of colored isometric views with different color shades shall be submitted for approval.

10.1.13 All flooring area other than foundations shall be designed as industrial floor with minimum 100 mm thick RCC floor slab, laid over well compacted stone soiling of minimum 200 mm thick using stone of size 150 mm & below with interstices filled with sand over well compacted earth.

10.2 GIS BUILDING / GIS HALL:

10.2.1 The New GIS building shall be of pre-engineered steel structure. GIS building consist of GIS hall, Room for control, protection & communication panels and AHU room. Provision for service bay and future extension of the building shall be made. During extension works in GIS hall, to keep the existing part of the building dust free, a temporary partition sheet of suitable material and strength shall be provided without any additional cost to POWERGRID. The same shall be removed after completion of work and taken back by contractor. Suitable space shall be provided to facilitate maintenance of GIS equipments. Panels shall be kept in an air-conditioned enclosure. The building shall be designed for future expansion also. Building shall be designed in such a manner that the same crane shall be extended in future expansion. Loads, structural design, fabrication & erection, material etc. of PEB structure shall be as per BIS standards

10.2.2 In case of extension of GIS building, the same shall be matched with existing type either PEB or conventional.

10.2.3 Size of the building shall be as per requirement of GIS modules, panel, O&M needs and housekeeping considerations. Any clearance required as per Electricity Act or any other Standard shall also be kept. Separate fire escape doors shall also be provided in the GIS Building

- 10.2.4 A Glazed partition made of aluminum extruded sections powder coated frame (min. 50 micron powder coating) and 5.5 mm (min) thick glass shall be provided between GIS hall and panel room. The total height of glazed partition shall 3000 mm above FFL include sill level of 900mm. Up to sill level full brick masonry wall to be provided and finished with Non-VOC acrylic emulsion paint to give an even shade on plastered surface over 2mm POP putty.
- 10.2.5 Over all Width of crane walk way shall not be less than 1.0m and shall be provided at gantry girder level on the two longer side of GIS hall along with climbing arrangement to facilitate maintenance of crane. Suitable arrangement shall be made on top of the crane, to facilitate maintenance of lighting fixtures. Structural steel of walkway shall be finished with priming coat of standard steel primer followed by one coat of epoxy paint and final coating of PU (Minimum 100 Micron). The minimum clear height of the building shall be kept 1800 mm from the top of walk way or 600 mm above the top most point of crane, whichever is higher.
- 10.2.6 The base plate of steel columns shall be mounted on the RCC foundation by means of hot dip galvanized foundation bolts (The zinc coating shall be minimum 610 gram per square meter. In case the substation is located within 30km from sea coast, the zinc coating shall be 900gm per square meter. The purity of zinc shall be 99.95% as per IS: 209). The RCC pedestal shall not protrude above floor level to avoid obstruction in the movement.
- 10.2.7 PVC electrical conduits of ISI marked or IS approved shall be provided as per the requirement of electrical installations its accessories, junction boxes/surfaces boxes, fan boxes etc. Areas where false ceiling is provided and on puff panels, electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area. In rest area conduit & junction boxes, fan boxes etc. shall be concealed wherever brick wall/RCC is provided.
- 10.2.8 The walls of GIS building and the attached relay room shall be of full brick and up to a height of 150mm above false ceiling level of relay room. Rest portion shall be provided with puff sandwiched panels as mentioned elsewhere in TS.
- 10.2.9 Open cable trenches in the GIS hall shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of epoxy paint as per item 13.52 of DSR' 2014 over a coat of steel primer.
- 10.2.10 Colour Scheme matching with local aesthetic and best industry practices shall be submitted by vendors for approval of POWERGRID. Three alternatives of coloured isometric views with colour codes shall be submitted for approval. The monotony of external colour of sheet shall be avoided by providing vertical bands of different coloured sheet. The colour of roof sheet shall be light coloured to minimize heat absorption. External and internal

masonry walls shall be painted with suitable approved colour in consultation with Employer.

10.2.11 All external openings for duct entries shall be provided with all round sunshade/chajjas to ensure that no rain water shall directly splashes on the sealant.

10.2.12 All flooring area other than foundations shall be designed as industrial floor with minimum 100 mm thick RCC floor slab, laid over well compacted stone soiling of minimum 200 mm thick using stone of size 150 mm & below with interstices filled with sand over well compacted earth and with floor finish as per table - 1.

10.3 BUILDING DESIGN CONSIDERARIONS:

THE CONTROL ROOM BUILDING & GIS BUILDING SHALL BE DESIGNED:

10.3.1 To the requirements of the National Building Code of India, and the standards quoted therein.

10.3.2 For the specified climatic & loading conditions.

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

10.3.4 With a functional and economical space arrangement.

10.3.5 To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.

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

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

10.3.8 With materials preventing dust accumulation.

10.3.9 With the FFL of building shall be minimum 750 mm above finished ground level or as indicated in the tender drawings. In case of extension of existing buildings, FFL should match with the existing buildings.

10.3.10 With anti-termite treatment, plinth protection, DPC, peripheral drain, sanitary, water supply, electrification etc.

10.3.11 With the building lighting, in accordance with the requirements of relevant section.

- 10.3.12 With the building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services, in accordance with the requirements specified in relevant section or elsewhere in this Specification.
- 10.3.13 Most critical combinations of dead loads, super- imposed loads, equipment loads, crane load, wind loads, Snow load, seismic loads, any other load etc whichever is applicable shall be considered.
- 10.3.14 The individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion deflection etc.
- 10.3.15 The permissible stresses for different load combinations shall be taken as per relevant BIS Codes.
- 10.3.16 All structures and its components must be designed and detailed as per latest BIS standards incorporating ductile detailing. List of reference codes e.g IS 456-2000 (latest), IS 875 all parts, IS 1893 all parts, IS 4326, IS 13920, SP34 etc.
- 10.3.17 RCC columns shall be provided with rigid connection at the base.
- 10.3.18 The design of steel structures for the Pre-engineered buildings shall be done in accordance with IS: 800-2007 with limit state method or elsewhere mentioned in section project.
- 10.3.19 Limit state method of Concrete design shall be adopted unless specified otherwise in the specification.
- 10.3.20 Clear cover to reinforcement shall be as per IS: 456 (latest).
- 10.3.21 Expansion joints wherever necessary with provision of twin columns shall be as per the provisions of relevant IS or National building codes.
- 10.3.22 Any sub-soil water encountered at founding level, same shall be considered in the design.
- 10.3.24 For maintaining adequate air pressure inside GIS Halls following measures need to be adopted:
1. Elastomeric sealants to be provided at doors/windows junction with walls, duct entry points, roof joint, etc. to check any air leakages.
 2. Cable sealing system shall be provided at the cable entry points.
 3. Mats to be provided on cable trenches to reduce air leakage.
 4. External doors shall be inward opening.
 5. Providing of an air lock lobby for separating the inside area of GIS hall.

10.4 DESIGN LOADS:

The following loads shall be considered in design, in addition to the equipment manufacturer's requirements if any. However, all the loads, which are required for design, are subjected to employer's approval.

10.4.1 DEAD LOADS

- i) Dead loads shall include the self-weight of all structures complete with finishes, fixtures and partitions.
- ii) In addition, RCC beams shall be designed for any incidental point loads to be applied at any point along the beams if applicable.

10.4.2 IMPOSED LOADS

- i) Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads wherever these loads are expected. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.
- ii) Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Cable load shall also be considered additionally for floors where these loads are expected.
- iii) The floor loads shall be subject to Employer's approval. Floors shall be designed for live loads as per relevant IS 875 part 2 (latest), however, for Buildings, the following loads may be considered.

Roof	1.5 kN/m ² for accessible roofs and 0.75 kN/m ² for in-accessible roofs
RCC-Floor	i) 5 kN/m ² for offices ii) 10 kN/m ² (min.) for equipment floors or actual requirement, if higher than 10kN/m ² on
	equipment component and layout plans
Stairs & balconies	5 kN/m ²
Toilets	2 kN/m ²
Chequered plate floor	4 kN/m ²
Walkways	3 kN/m ²

- iv) For crane loads an impact factor of 30% and lateral crane surge of 10% (lifted weight + trolley) shall be considered in the analysis of frame according to provisions of IS:875. The horizontal surge shall be 5% of the static wheel load. Crane load shall be applied as per the requirement of building.

10.4.3 WIND LOAD

- i) The wind loads shall be computed as per IS 875 part 3 (latest), the class of structure for design, k1 factor, shall be considered under the category as 'important buildings and structures like hospitals, communication buildings/towers, power plant structures' for Control Room building, GIS hall, Towers, Gantries, equipment structure. For other buildings/structures wind loads shall be computed as per IS 875 part 3 (latest).
- ii) Wind and Seismic forces shall not be considered to act simultaneously.

10.4.4 SEISMIC LOAD

- i) Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS: 1893: Part 1 with importance factor 1.5.
- ii) Wind and Seismic forces shall not be considered to act simultaneously.

10.4.5 SNOW LOAD

- i) Snow load shall be computed as per IS:875 part 4 (latest).
- ii) When snow load is present in roofs, replace imposed load by snow load in respective load combinations.

10.4.6 LOAD COMBINATIONS

- i) The critical load combinations for design of RCC structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 456 (latest), IS: 1893- part 1 (latest). ii) The critical load combinations for design of Steel structures shall be computed or generated by using IS: 875 Part-5 (latest), IS: 800, IS: 1893- part 1 (latest).

10.5 DESIGN OF FOUNDATIONS FOR BUILDINGS & OTHER SWITCH YARD STRUCTURES:

- 10.5.1 All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456. Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction

10.5.2 The switchyard foundation's plinths shall be minimum 300mm and buildings plinth shall be minimum 600 mm above finished ground level respectively. If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

10.5.3 The tower and equipment foundations shall be checked for a partial factor of safety of 2.2 for normal condition and 1.65 for short circuit condition.

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

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

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

10.5.7 If pile foundations are adopted, the same shall be cast-in-situ bored or pre-cast or under reamed type as per relevant parts of IS: 2911. Only RCC piles shall be provided. Necessary initial load test shall be carried out by the Contractor to establish the pile design capacity. Only after the design capacity of pile has been established, the Contractor shall take up the job of piling. Routine tests for the pile shall also be conducted as per IS: 2911/IS :10262. All the testing work shall be planned in such a way that these shall not cause any delay in project completion. RCC for pile works shall be Design Mix of minimum grade M-25 and also minimum cement content shall be 400Kg/ cu.m as per IS:2911 (Latest revision). In case extra cement is required to meet the provisions of IS: 2911, it will be paid extra.

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

10.6 DESIGN OF TRANSFORMER AND REACTOR FOUNDATION:

10.6.1 The foundations of Transformer & Reactor shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. In case of Reactor Plan dimension of block should not be less than size of base of reactor.

- 10.6.2 The Contractor shall provide a RCC Rail cum road system integrated with the Autotransformer / Reactor foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil.
- 10.6.3 This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS.
- 10.6.4 The Contractor shall provide a pylon support system for supporting the firefighting system.
- 10.6.5 Each Autotransformer/Reactor including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Autotransformer/Reactor shall be 20% of the Autotransformer/Reactor/ cooler bank height or 0.8m whichever is higher. The oil collection pit thus formed shall have a void volume equal to 200% volume of total oil in the Autotransformer/Reactor. In case of transformers of 132kV and below, where hydrant system for firefighting is not provided, volume of pit may be reduced to 130% of total oil volume. However, in case common oil pit is envisaged during detailed engineering, the individual oil collection pit thus formed shall have a void volume equal to 33% volume of total oil in the Autotransformer/Reactor. The common oil collection pit shall have a void volume equal to 200% volume of maximum total oil of either Autotransformer or Reactor.
- 10.6.6 The minimum height of the retaining walls of pit shall be 20 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the autotransformer / reactor must be taken into account.
- 10.6.7 The grating shall be made of MS flat of size 30mm x 5mm placed at 30mm centre to centre and 6mm dia MS bar at spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150 mm, shall be placed at the formation level and will be covered with 100mm thick layer of stone aggregate having size 40mm to 60mm. All steel work used for grating and supports shall be painted with epoxy based zinc phosphate primer (two packs) conforming to IS: 13238- 1991, thereafter with two or more coat of bituminous paint of approved quality shall be applied. Contractor shall have option to provide factory made electro forged MS grating made of specified size MS flat and round bars without any extra cost to employer.

10.6.8 Each oil collection pit shall be drained towards a sump pit of size 1000X750mm and 500mm deep below the floor level within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

10.7 DESIGN OF FIRE PROTECTION WALLS:

10.7.1 The construction of fire walls shall be cast in situ type or pre cast RCC as per drawings and meeting the technical specification.

10.7.2 The firewall shall have a minimum fire resistance of 4 hours. The walls of the building, which are to be used as firewalls, shall have also a minimum fire resistance of 4 hours. The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

10.7.3 The firewall shall extend 600 mm on each side of the Autotransformer or Reactors and 600 mm above the conservator tank or safety vent. A minimum of 2.0 meter clearance shall be provided between the equipment's e.g. Autotransformer or Reactors and firewalls. In case of space constraints, these dimensions can be reduced as per the approval of Employer.

10.7.4 The building walls, which act as firewalls, shall extend at least 1 m above the roof or 600 mm above the conservator tank or safety vent, whichever is maximum, in order to protect it.

10.7.5 The firewall will be made of reinforced cement concrete with smooth surfaces devoid of honey comb, undulations etc. and shall be finished with water proofing cement paint of approved colour.

10.8 DESIGN OF WATER TANKS, CHANNELS, SUMPS, TRENCHES AND OTHER UNDER-GROUND STRUCTURES:

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

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

10.8.3 Earth pressure for all underground RCC structures like cable trenches, underground water tanks, Oil collection pits, Septic tanks, basements etc. shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

10.8.4 In addition to earth pressure and ground water pressure etc., a surcharge load of $2T/Sq.m$ shall also be considered for the design of all underground structures for the vehicular traffic in the vicinity of the structure.

10.8.5 Underground tanks shall be checked for full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid). They shall also be checked for full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

10.8.6 Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

10.8.7 Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

10.9 INTERNAL FINISH SCHEDULE FOR BUILDING & GIS HALL EITHER RCC/ PEB:

10.9.1 Internal finishing Schedule for control room building and GIS hall is given in Table - 1 below:
The Locations, which are not specified in finish schedule, shall be provided with vitrified tile flooring and premium acrylic emulsion paint over two mm thick POP putty. The below mentioned finishing schedule is also applicable for extension of Control room or GIS hall unless otherwise mentioned else-where in the Tender. Areas where false ceiling is provided, electrical conduit may be laid on exposed surfaces of walls or ceiling, above false ceiling area.

Table-1

Sr. No.	LOCATION	FLOORING & SKIRTING 150MM HIGH	WALL (INTERNAL)	CEILING	DOOR, WINDOWS & VENTILATOR
1	Control Room	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	Windows shall be of min. 10mm thick laminated float safety glass conforms to IS: 2553 (Part-I) by using suitable powder coated aluminum extruded sections peripheral frame. The glazed window shall be provided between column to column horizontally and vertically from sill level of 0.75 m to bottom false ceiling. In a window 2 to 3 vertical pieces may be provided depending upon the availability of glass and the vertical joint shall be sealed with silicon sealant. All doors shall be glazed powder coated aluminium doors with minimum 5.5 mm thk. glass
2	Confer-ence Room	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.

			over approved primer coat		
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3	(S/S In-charge Room)	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
4	Other Office Rooms	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat.	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
5	Electronics Test Lab.	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
6	ACDB& DCDB Room	62mm thick cement concrete flooring with hardener	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat	Non VOC acrylic emulsion paint over approved primer coat for RCC Building / False ceiling shall be provided in-case of PEB building.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
7	Battery room	Vitrified tiles size 600 x 600mm (DSR Item	Non VOC acrylic emulsion paint over 2mm POP putty upto	False ceiling painted with Non VOC acrylic emulsion paint to give an even	All doors Windows/ventilator shall be glazed uPVC doors with minimum 5.5.mm thk. Glazing.

		11.46)	false ceiling over approved primer coat	shade.	
8	Lobby	18mm thick granite flooring (DSR Item 8.12)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
9	Corridor	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
10	Portico for RCC Building	18mm thick granite flooring (DSR Item 8.12)	Granite cladding	Non VOC acrylic emulsion paint over approved primer coat	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
11	Toilet	Ceramic tiles (DSR item 11.38)	DADO glazed tile 2100mm high, above that non VOC acrylic emulsion paint over 2 mm thick POP putty along with primer coat.	Non VOC acrylic emulsion paint over approved primer coat for RCC building / False ceiling shall be provided in-case of PEB building.	All windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing. All doors shall be flush door shutters made of pre-laminated particle board (DSR 9.131 & 9.132) with powder coated aluminum frame.

12	Janitor room	Ceramic tiles (DSR item 11.38)	DADO glazed tile 2100mm high, above that non VOC acrylic emulsion paint	Non VOC acrylic emulsion paint over approved primer coat for RCC building / False ceiling	All windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing. All doors shall be flush door shutters made of
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			over 2mm thk. POP putty along with primer coat.	shall be provided in-case of PEB building.	pre-laminated particle board (DSR 9.131 & 9.132) with powder coated aluminium frame.
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13	GIS Hall	62mm thick cement concrete flooring with hardener. Two coats of PU coating over the floor shall be provided. over the total area (Present + Future). The final coat of PU shall be applied after Installation of equipments . Total thickness of PU coats shall be minimum 300 microns.	Non VOC acrylic emulsion p over 2mm putty upto over approved primer plastered ceiling coat surface	In case of RCC roof, ceiling shall be finished with Non VOC acrylic emulsion paint over approved primer coat.	All doors, windows, ventilators shall be of uPVC with minimum 5.5.mm thk. Glazing.
14	Panel/ Relay Room/	Vitrified tiles 8mm thick size	Non VOC acrylic emulsion p	False ceiling painted with Non VOC acrylic	All doors, windows, ventilators shall be of uPVC with minimum

	Communication Room	600x600mm	over 2mm POP putty upto false ceiling over approved primer coat over plastered surface	emulsion paint to give an even shade.	5.5mm thk. Glazing.
15	AHU Room	62mm thick cement concrete flooring with hardener	Non VOC acrylic emulsion paint over 2mm POP putty upto false ceiling over approved primer coat over plastered surface	RCC ceiling finished with non-VOC acrylic emulsion paint over approved primer coat.	All windows, ventilators shall be of uPVC with minimum 5.5mm thk. Glazing. All doors shall be flush door shutters (35mm thk. block board with commercial veneer on both side with lipping) with powder coated aluminium frame.

uPVC doors, windows, ventilators shall be sliding or openable or partially openable/partially fixed or fixed type of factory made uPVC doors, windows (casement/sliding), ventilators, fixed glazing and partitions as per DSR '16 item no. 9.147A to 9.147F.

10.10 FALSE CEILING DETAILS:

10.10.1 For the locations of false ceiling refer table -1 above, unless otherwise specified elsewhere in tender documents.

10.10.2 15mm thick densified tegular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture spintone/cosmos/ Hexa or equivalent of size 595x595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanised steel sections (galvanising @ 120 grams per sqm. Including both side).

Consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross 'T' of size 24x28 mm made out of 0,33 mm (minimum) sheet, 1200 mm long spaced between main 'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size of 24x28 mm made of 0.33 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grid of size 600x600 mm, resting on periphery walls/partitions on a perimeter wall angle precoated steel of size (24x24x300 mm made of 0.40 mm thick (minimum) sheet with the

help of rawl plugs at 450 mm centre to centre with 25 mm long drywall screws @230 mm interval and laying 15 mm thick densified edges calcium silicate ceiling tiles of approved texture (Spintone/ Cosmos/ hexa) in the grid, including, cutting/making openings for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., Wherever required.

Main 'T' runners to be suspended from, ceiling using G.I. slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I. adjustable rods with galvanised steel level clips of size 85x30x0.8 mm, spaced at 1200 mm centre to centre along main 'T', bottom exposed with 24 mm of all T-section shall be pre-painted with polyester baked paint, for all heights, as per specifications, drawings and as directed by engineer- in-charge.

10.11 WATER PROOFING TREATMENT

10.11.1 Integral cement based water proofing treatment including preparation of surface as required for treatment of roofs, balconies, terraces etc consisting of following operations:

- a) Applying a slurry coat of neat cement using 2.75 kg/sqm. of cement admixed with water proofing compound conforming to IS. 2645 and approved by Engineer-in-charge over the RCC slab including adjoining walls upto 300mm height including cleaning the surface before treatment.
- b) Laying brick bats with mortar using broken bricks/brick bats 25 mm to 115 mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge over 20 mm thick layer of cement mortar of mix 1:5 (1 cement :5 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs
- c) After two days of proper curing applying a second coat of cement slurry using 2.75 kg/ sqm of cement admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge.
- d) Finishing the surface with 20 mm thick joint less cement mortar of mix 1:4 (1 cement :4 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge including laying glass fibre cloth of approved quality in top layer of plaster and finally finishing the surface with trowel with neat cement slurry and making pattern of 300x300 mm square 3 mm deep.
- e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge

- f) With average thickness of 120mm and minimum thickness at khurra as 65 mm.

10.11.2 Alternatively in case of non- availability of good quality of brick bats, the water proofing treatment can also be done in the following manner:

The water proofing membrane shall be laid on the RCC slab without any break. The grading concrete (1:2:4) of average thickness of 50 mm with water proofing compound as per manufacturer's specification shall be laid over the membrane. Cement concrete flooring of 40mm thick with (1cement: 2 fine aggregate: 4 stone aggregate 20mm graded stone aggregate) finished with a floating coat of neat cement including cement slurry complete shall be laid over grading concrete and checkered pattern in the grid of 300mm x 300mm shall be made .

10.11.3 SUNKEN WATER PROOFING (RCC):

- ☑ Water proofing treatment shall be done in sunken portion of WCs, bathroom etc. by applying cement slurry mixed with water proofing cement compound consisting of:
 - a) First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.
 - b) Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours.
- ☑ Treatment and sealing of joints, corners, junction of pipes and masonry with polymer mixed slurry shall be carried out as per CPWD specifications.

10.12 SPECIFICATION FOR PLUMBING, SANITATION & WATER SUPPLY ETC:

10.12.1 All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.

10.12.2 Provision for water cooler shall be provided at suitable location.

10.12.3 Each toilet shall be provided with Water Closet, Wash hand basin, health faucet, Mirror, Towel Rail, Paper Holder, Liquid soap dispenser, twin coat holder.

10.12.4 In addition to general requirements of each toilets, 2 nos. Sensor based urinals shall be provided for common Gents toilet.

10.12.5 Pantry shall be provided with stainless steel kitchen sink.

10.12.6 The platform of kitchen sink and wash hand basin shall be provided with 18 mm thk. Mirror polished approved granite stone.

10.12.7 The specification of different items, which are to be used for plumbing, sanitation & water supply etc. in are given below, the same shall be used during detailed engineering, unless otherwise mentioned else-where in the tender.

S.No.	Items	Description
1	Wall hung Water Closet	Coloured vitreous china extended wall mounting water closet of approved size and shape including providing & fixing white vitreous china cistern with dual flush fitting, of flushing capacity 3 litre/6 litre (adjustable to 4 litre/8 litres), including seat cover, and cistern fittings, nuts, bolts and gasket etc complete.
2	Squatting Pan	(Indian type W.C. pan) (white vitreous china Orissa pattern W.C. pan of size 580x440mm with integral type foot rests) shall be with 100mm sand cast iron P or S trap. 10 litre low level white P.V.C flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required.
3	Wash Basin	Providing and fixing coloured wash basin counter type of (approximate size 630x450mm size under counter or over counter type), in case flat bash hand is required the approximate size shall be 550x400mm and shall be provided with C.P. close basin mixer (ISI approved) with Cl. Brackets taps with battery based infrared sensor, 32mm C.P. brass waste and bottle trap of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required. Other details shall be as per the drawings.
4	Urinal	White vitreous china battery based infrared sensor operated urinal of approx. size 610 x 390 x 370 mm having pre & post flushing with water (250 ml & 500 ml consumption), having water inlet from back side, including fixing to wall with suitable brackets all as per manufacturers specification and direction of Engineer-in-charge.
5	Urinal partition	10mm thk toughened glass partition with frosted film to be fixed in position for urinals on appropriate stainless steel patch fittings of desired shape and size

6	Kitchen sink	Stainless steel AISI 304 (18/8) Kitchen sink of 510x1040 mm bowl with depth of 178mm with drain board shall be provided and fixed as per IS 13983 with C.I brackets, and stainless steel plug 40mm with provision of 2 nos. CP brass long body bib cock conforming to IS Standard and weighing not less than 650 gm for CP bottle trap etc.
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		including painting of fittings and brackets, cutting and making good the wall.
7	Bib cock	C.P. brass short body and long body bib cock 15mm nominal bore shall be of approved quality conforming to IS: 8931.
8	Angle valve	C.P. brass angle valve of 15mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS :8931.
9	Towel rail	C.P. brass towel rail of approved make of 600mm length, 25mm dia with a pair of brackets or flanges provided and fixed to wall beside each wash basin/set of wash basin with necessary screws, plugs, etc.
10	Mirror	6mm thick beveled edge mirror approximate size 1000x600mm made of superior glass of approved make complete with a backing of 6 mm thick water proof hard board fixed to wooden cleats with 25mm dia SS studs, washers etc complete for each wash basin.
11	Hooks	Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.
12	Liquid soap holder	C.P. brass liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP brackets, CP screws, washers, plugs etc.
13	C.P. Brass or S.S. cockroach trap	Approved C.P. Brass cockroach trap shall be provided in the Kitchen, Toilets and pantry
14	Floor traps	PVC floor traps of self cleansing design shall be provided & fixed in position with 100 mm dia. inlet and 75mm dia. outlet of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150 mm thick PCC 1:2:4.

15	Internal Soil, waste and vent pipe	Unplasticised rigid PVC pipes of 75mm for waste & 110mm dia for soil shall be provided conforming to IS:13592 type B and all its fittings like bends, sockets, door bend, Y-tee etc. as per requirement with seal ring conforming to IS: 5382 including jointing with cement solvent conforms to IS:14182. All underground or under floor pipes shall be encased with 1:3:6 concrete. Minimum concrete cover shall be 75 mm thk.
16	Rain Water Pipe and fittings	<p>a) Unplasticised rigid PVC rain water pipes of required dia shall be provided and fixed on the wall face conforming to IS: 13592 type A as per requirement including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion single socketed pipes including all fittings like bends, bat clamps gratings etc.</p> <p>b) Unplasticised PVC Moulded fittings/accessories including suitable dia. bend & shoes shall be provided and fixed for unplasticised rigid PVC rain water pipes conforming to IS:13592 type A including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion.</p> <p>c) Clips of approved design shall be provided and fixed to unplasticised PVC rain water pipes by means of 50x50x50mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc</p>
17	Internal & External water supply	<p>a) All CPVC pipes and fittings shall conform to IS:15778</p> <p>b) All internal CPVC pipe shall be concealed including cutting of chases and making good the wall.</p> <p>c) Wherever CPVC pipes are buried the same shall be provided and laid in position including trenching, sand cushion and refilling, etc. For trenching, sand cushion and refilling refer CPWD specification applicable for external piping work.</p> <p>d) All internal CPVC pipe shall be concealed including cutting of chases and making good the wall.</p> <p>e) ISI approved CPVC ball valve, non-return valves shall be provided and fixed in position as per requirement and direction of Engineer-in-charge.</p>
18	Water storage tanks	Triple layered Polyethylene water storage tanks shall be provided of approved brand and manufacture with cover and suitable locking arrangement, float valve and making necessary holes for inlet, outlet and overflow pipes. Capacity of water tank shall be 2x1500 litres for control room, 2x2000 litres for Transit Camp.

19	Sluice valve chamber	Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 50 class designation brick work in cement mortar 1:5 (1 cement : 5 fine sand) with CI surface box 100 mm. Top diameter, 160 mm bottom dia and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1cement : 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine aggregate : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1
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		cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with FPS bricks of class 75.
20	External Sewerage	Glazed stoneware pipes of 100 & 150mm diameter grade 'A' shall be provided, laid and jointed with stiff mixture of cement mortar in the proportion of 1:1 (1cement :1 fine sand) including testing of joints etc. complete. SW pipes shall be encased with Cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size) including bed concrete as per CPWD standard design and CPWD specifications. In case of non-availability of SW Pipe, contractor may use UPVC Pipe of similar dia with the prior approval of EIC without any financial implication to POWERGRID.
21	Gully trap	100x100 mm or 150x100 mm size P type Square-mouth S.W. gully trap class SP-1 complete with C.I. grating brick masonry chamber and water tight C.I. cover frame o f 300 x300 mm size (inside), the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as per standard design. FPS Bricks class designation 75 shall be provided for brick masonry chamber.

22	Manholes	<p>FPS brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement :4 coarse sand) RCC top slab with 1:2:4 mix (1 cement : 2 fine aggregate : 4 graded stone aggregate 20 mm nominal size) foundation concrete 1:4:8 mix (1cement : 4 coarse sand :8 graded stone aggregate 40 mm nominal size) inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1 cement: 2 coarse sand :4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement complete as per standard design. The size and depth of manhole shall be suitably decided based on requirement of layout in line with CPWD specification.</p> <p>a) Inside size shall be 90 x 80 cm and 60 cm deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and shall be constructed with F.P.S. bricks with class designation 75.</p> <p>b) Inside size shall be 120 x 90 cm and 90 cm or more deep including CI cover with frame (medium duty) 500mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) with FPS Bricks class designation 75.</p>
23	Foot Rest	<p>Orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910, on 12 mm dia steel bar conforming to IS: 1786, having minimum cross section as 23 mmx25 mm and over all minimum length 263 mm and width as 165 mm with minimum 112 mm space between protruded legs having 2 mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing and suitable to with stand the bend test and chemical resistance test as per specifications and having manufacture's permanent identification mark to be visible even after fixing, fixing in manholes with 30x20x15 cm cement concrete block 1:3:6 (1 cement : 3 fine aggregate : 6 graded stone aggregate 20 mm nominal size) complete.</p>
24	Road Gully Chamber	<p>Brick Masonry road gully chamber of 50x45x60cm shall be provided with FPS brick with cement mortar 1:4 including 500x450mm pre cast RCC Horizontal/vertical grating with frame complete.</p>

11.0 MATERIAL SPECIFICATION FOR ALL PRE-ENGINEERED BUILDINGS:

11.1 STRUCTURAL STEEL MEMBERS:

11.1.1 Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns and crane gantry girders and Frames at Door openings.

11.1.2 Primary members are fabricated from plates and sections with minimum yield strength of 340 Mpa to suit design by continuous double side welding.

11.1.3 All miscellaneous structural members, rod bracings, angle bracings, pipe bracings, wind bracings, sag rods, etc. shall conform to the physical specification of IS: 2062 with a minimum 245Mpa Yield Strength.

11.1.4 All welded structural steel members shall be provided with suitable treatment of shot blasting before application of steel primer.

11.1.5 All structural steel members including walk way structural steel members shall be painted with a steel priming coat followed by one coat of epoxy paint and final coating of PU (Minimum 100 Micron).

11.1.6 The structural steel members of cage ladder shall be galvanized with 610 gm/sqm.

11.2 PURLINS AND GIRTS MEMBERS:

11.2.1 Purlins, girts, necessary clips and other cold rolled structural members shall conform to the physical specification of ASTM A570 (Grade 50) or equivalent IS Standards having a minimum yield strength of 340 MPa and shall be of Pre galvanised having a total coating thickness of 275 gm/sqm. inclusive of both sides.

11.2.2 The minimum thickness of secondary members shall be 2.5mm.

11.3 ROOF & WALL SHEETING:

11.3.1 Factory assembled 50mm thick puff (overall average density 40kg/cu.m. +/- 2 Kg/cu m as per IS: 11239 Part-2) sandwiched panels shall be provided. These panels shall be made of puff insulation sandwiched between two high tensile steel sheets each of 0.5 mm thickness. The material of sheets shall confirm to ASTM 792 M with minimum yield strength of 340 Mpa. However, higher grades of steel sheet may be supplied without any further cost implication.

11.3.2 The steel sheets shall be provided with hot dip coating of Zinc aluminium alloy (approximately 55% Al, 43.5% Zn and 1.5 % silicon). Total mass of zinc aluminium alloy coating shall be

minimum 150 gm/Sq. m inclusive of both sides. The tolerance of base metal thickness (BMT) of steel sheet shall be as per IS 16163. After hot dip coating of Zinc aluminium alloy, the sheet shall be provided with steel primer and silicon modified polyester (SMP) paint. The total thickness of primer and paint shall be 40 microns inclusive of both sides (TCT) comprising of 20 microns of SMP paint on top surface and 10 microns of backer coat (polyester coat) on back surface over 5 microns thick primer each on both surfaces with inorganic pigments coated free from heavy metals. Painting shall conform to IS: 15965. In case SMP paint is not available, Super Durable Polyester paint (SDP) can also be used by the bidder without cost implication to POWERGRID.

11.4 SHEETING FASTENERS:

Standard fasteners shall be self tapping zinc plated metal screws with EPDM bonded zinc plated washers. All screws shall be colour coated to match roof and wall sheeting.

11.5 SEALER:

This is to be applied at all side laps and end laps of roof panels and around self flashing windows. Sealer shall be pressure sensitive elastomeric Butyl tapes. The sealer shall be non-asphaltic, non-shrinking and non toxic and shall be superior adhesive metals, plastics and painted at temperatures from 51°C to +104°C.

11.6 CLOSURES:

Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations. It should be specifically specified on drawings. The steel sheets shall be provided with hot dip coating of Zinc aluminium alloy (approximately 55% Al, 43.5% Zn and 1.5 % silicon). Total mass of zinc aluminium alloy coating shall be minimum 200 gm/Sq. m inclusive of both sides. The tolerance of base metal thickness (BMT) of steel sheet shall be as per IS 16163. After hot dip coating of Zinc aluminium alloy, the sheet shall be provided with steel primer and silicon modified polyester (SMP) paint. The total thickness of primer and paint shall be 40 microns inclusive of both sides (TCT) comprising of 20 microns of SMP paint on top surface and 10 microns of backer coat (polyester coat) on back surface over 5 microns thick primer each on both surfaces with inorganic pigments coated free from heavy metals. Painting shall conform to IS: 15965. In case SMP paint is not available, Super Durable Polyester paint (SDP) can also be used by the bidder without cost implication to POWERGRID.

11.7 FLASHING AND TRIM:

Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. The steel sheets shall be provided with hot dip coating

of Zinc aluminium alloy (approximately 55% Al, 43.5% Zn and 1.5 % silicon). Total mass of zinc aluminium alloy coating shall be minimum 200 gm/Sq. m inclusive of both sides. The tolerance of base metal thickness (BMT) of steel sheet shall be as per IS 16163. After hot dip coating of Zinc aluminium alloy, the sheet shall be provided with steel primer and silicon modified polyester (SMP) paint. The total thickness of primer and paint shall be 40 microns inclusive of both sides (TCT) comprising of 20 microns of SMP paint on top surface and 10 microns of backer coat (polyester coat) on back surface over 5 microns thick primer each on both surfaces with inorganic pigments coated free from heavy metals. Painting shall conform to IS: 15965. In case SMP paint is not available, Super Durable Polyester paint (SDP) can also be used by the bidder without cost implication to POWERGRID.

11.8 WALL LIGHTS:

For day lighting purpose of GIS hall, minimum 2 mm thick approved translucent polycarbonate sheet shall be provided for wall lighting in addition to windows for at least 10% of wall area on upper portion of both long walls. The polycarbonate sheet shall be fixed with necessary EPDM/rubber gasket, Silicon Sealant, cold forged fastener, aluminum profile etc. including MS supporting structural steel (conforming to IS:1161/4923) frame to ensure water tight arrangement.

11.9 CONNECTIONS:

11.9.1 SITE CONNECTIONS

- i) All primary bolted connections shall be provided with galvanized high strength bolts, washers, nuts conforming to specifications of grade 8.8 of IS 1367/IS:3357
- ii) All secondary bolted connections shall be furnished with bolts, nuts, washers conforming to the specifications of grade 4.6 of IS 1367 or ASTM-A307.

11.9.2 SHOP CONNECTIONS

All shop connections shall be welded with appropriate arc welding process and welding shall be in accordance with IS: 816, IS -818, IS1024, IS:1261, IS1323, IS-9595, AWS D 1.1. as appropriate. The Webs should be welded on to the flanges at both the faces at top and bottom for columns, beams and crane girders. Weld material should have strength more than the parent metal.

11.10 GUTTERS AND DOWN SPOUTS:

Gutters and downspouts shall be adequately designed to ensure proper roof drainage system. The steel sheets shall be provided with hot dip coating of Zinc aluminium alloy

(approximately 55% Al, 43.5% Zn and 1.5 % silicon). Total mass of zinc aluminium alloy coating shall be minimum 200 gm/Sq. m inclusive of both sides. The tolerance of base metal thickness (BMT) of steel sheet shall be as per IS 16163. After hot dip coating of Zinc aluminium alloy, the sheet shall be provided with steel primer and silicon modified polyester (SMP) paint. The total thickness of primer and paint shall be 40 microns inclusive of both sides (TCT) comprising of 20 microns of SMP paint on top surface and 10 microns of backer coat (polyester coat) on back surface over 5 microns thick primer each on both surfaces with inorganic pigments coated free from heavy metals. Painting shall conform to IS: 15965. In case SMP paint is not available, Super Durable Polyester paint (SDP) can also be used by the bidder without cost implication to POWERGRID.

12.0 VENDORS & MQP FOR PEB BUILDINGS

- 12.1 All the material required for Pre-engineered (steel) building shall be procured from approved vendors as per list of compendium of vendors available on POWERGRID web site or any other reputed manufacturer for which prior approval shall be obtained from POWERGRID.
- 12.2 Manufacturing of various parts of the building shall start only after approval of "Manufacturing Quality Plan". Design and structural drawings shall be approved by POWERGRID.
- 12.3 Shop/fabrication showing each and every detail along with bill of material for all members of structures, joints, nuts & Bolts, welding shall be prepared and approved by vendors as per standard practice of fabrication based on POWERGRID approved design and structural drawings.
- 12.4 Complete material shall be offered for inspection by CC (Corporate Centre) QA&I department before dispatch. Inspection of Material by POWERGRID CC QA &I deptt. shall be carried out based on Shop/fabrication drawing and BOM as approved by Vendors. Approval of BOM and shop/fabrication drawings from Employer is not required.

13.0 GENERAL SPECIFICATION FOR BUILDINGS:

These clauses are applicable for Buildings, which are to be constructed as per drawings provided by employer such as CRB, transit camp, residential buildings, switch yard panel room and fire water pump house with fire water tank. Architectural drawings of buildings covered in the scope are enclosed with the tender documents and are also available on website. These drawings are good for construction except for foundation drawings of the buildings which will be issued to the successful bidder after award of work and after receipt of soil investigation report depending upon soil parameters.

This shall also be applicable for vendor designed buildings wherever applicable.

In case of CRB and GIS halls, most of the finishing items are explained in previous clauses, if any of items are missed or may be required for completion of the same, the below mentioned clauses may also be referred.

- 13.1 The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan attached with this document which is available on POWERGRID web site. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification.
- 13.2 Post constructional Anti termite treatment shall be carried out for all buildings as per DSR item no. 2.34 & 2.35. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.
- 13.3 Reinforced cement concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, and water retaining structures for achieving water-tightness.
- 13.4 FPS or Modular clay/fly ash based Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm² compressive strength before submitting his offer. However, Contractor can propose to use aerated concrete block or solid concrete blocks of compressive strength not less than 75kg/cm² without any cost implication to POWERGRID.
- 13.5 Full brickwork shall be provided with cement mortar 1:6 (1cement: 6 coarse sand). Half brick work masonry shall be provided with cement mortar 1:4 (1cement: 4coarse sand) and two no 6mm dia ms bar at every third course.
- 13.6 12mm cement plaster of mix 1:6 (1cement: 6 fine sand) shall be provided on the smooth side of internal walls. However rough side of walls shall be provided with 15mm cement plaster of mix 1:6 (1cement: 6 fine sand).
- 13.7 External plaster in two coats - 18mm Cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement: 5coarse sand) finished with a top layer 6mm thick cement plaster (1cement : 6 fine sand). External plastered surface shall be finished with white cement based putty of average thickness 1 mm, of approved brand and manufacturer to prepare the surface even and smooth. After putty the walls shall be finished with Premium Acrylic Smooth exterior paint of approved brand and manufacturer with Silicone additives of required shade (Two or more coats applied @ 1.43 ltr/ 10 sqm. over and including priming coat of exterior primer applied @ 2.20 kg/ 10 sqm).

- 13.8 6 mm thk. Cement plaster of mix 1:3 (1 cement: 3 fine sand) to RCC ceiling shall be done except areas where false ceiling are provided.
- 13.9 Internal walls shall be finished with Plaster of Paris putty of average thickness 2 mm, of approved brand and manufacture, over the plaster surface to prepare the surface even and smooth complete. In case plastered surface of buildings are covered under wall paneling, dado work, skirting etc. no putty and painting are required.
- 13.10 Internal walls shall be painted with minimum two coats of premium acrylic emulsion paint having VOC (volatile organic compound) content less than 50gm per litre of approved brand and manufacture including applying additional coats wherever required, to achieve even shade and colour over priming coat as per manufacturer specification/ recommendation.
- 13.11 Non - VOC premium acrylic emulsion paint having volatile organic compound content less than 50gm per litre of approved brand and manufacture shall be used wherever specified.
- 13.12 Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be provided on the steel doors, flush doors and rolling shutters in various buildings or as specified in the drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.
- 13.13 Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors and frames.
- 13.14 Polished vitrified tiles in 60x60 cm size (thickness to be specified by the manufacturer) in flooring and skirting, with water absorption's less than 0.08% and conforming to IS: 15622 of approved make in all colours and shades, laid on cement mortar 20mm thick min. for flooring & 12mm thick for skirting 1:4 (1 cement: 4coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
- 13.15 Glazed Ceramic floor tiles 300x300mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS:15622 of approved make in colours as approved by Engineerin-charge in toilet and pantries area on 20mm thick min. cement mortar 1:4 (1 cement : 4coarsesand) including grouting the joints with white cement and matching pigments etc., complete.
- 13.16 62 mm thick cement concrete flooring with concrete hardener topping, under layer 50 mm thick cement concrete 1:2:4 (1 cement: 2 fine aggregate : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix: 2 graded stone aggregate, 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications.

- 13.17 Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement: 3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of neat cement. 21 mm thick in ACDB/DCDB room.
- 13.18 Granite stone of 18mm thick gang saw cut mirror polished pre-molded and pre-polished, machine cut for of required size of approved shade, colour and texture laid over 20mm thick base cement mortar 1:4 (1 Cement: 4 coarse sand) with joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing molding and polishing to edge to give high gloss finish etc. complete for staircase.
- 13.19 Granite stone of flooring with 18mm thick gang saw cut mirror polished premoulded and prepolished, machine cut for of required size of approved shade, colour and texture laid over 20mm thick cement mortar 1:4. The joints are filled with jointing compound matching to the granite. Wherever granite is specified for the floor, 100mm granite skirting shall be provided with the walls. The granite outer surface shall be flushed to the plaster finish of the wall by molding / beveling of granite at top edge.
- 13.20 Granite counter of approved shade shall be provided and fixed with 18mm thick gang saw cut, mirror polished, premoulded and pre-polished, machine cut for pantry & kitchen platform facias and similar locations of required size, approved shade, colour & texture laid over 20mm thick base cement mortar 1:4 (1cement : 4 Coarse sand) joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing moulding and polishing to edges to give high gloss finish etc complete at all levels.
- 13.21 Ceramic glazed wall tiles of 1st quality conforming to IS: 15622 (thickness to be specified by the manufacture) of approved make in all colours, shades as approved by Engineer-inCharge in dados over 12mm thick bed of cement Mortar 1:3 (1 Cement: 3 Coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete. Height of dado shall be 2.1m high in toilets, kitchen and pantry or elsewhere specified in the drawings or TS.
- 13.22 Rolling shutters shall be seamless galvalume motorized rolling shutters, with inclusion of features as under:

Slat material (Shutter curtain):	min. 1.0 mm steel slate (Galvalume)
Slat profiles	min. 100mm wide

Side guide	<p>GI side guides min. 75mm</p> <p>Especially design guides with wind locks for high wind velocity exposed shutters.</p> <p>Nylofelt seals fitted on the shutter skin for frictionless movement within the guides.</p>
Bottom profile	Aluminium bottom rail is provided with additional rubber seal for tight closing for prevention of dust entry.
Roller shaft	Roller shaft shall be heavy duty mild steel strong suspension tubular shaft without springs.
Side brackets	M.S. plate 3 mm to 10 mm as per the opening dimension.
Surface Finish & Painting	Primer and Duco paint (Matt finish)
Operations	Electrically operated with motor of suitable capacity along with manual operation by hand chain or hand crank for emergency

13.22 Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140 mm, 73 mm height, 3 mm thick rim, top and bottom lid of 1.5 mm M.S. Sheet. Lids shall be screwed in to M. S. box by means of 3 mm round headed screws, clamps shall be made of 12 mm dia. M. S. bar bent to shape as per standard drawing with overall length as 80 cm.

13.23 Powder Coated (minimum thickness 50 micron) aluminium work for doors, windows, ventilators and partitions shall be provided and fixed in building with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass/ stainless steel screws including glazing and fittings as specified.

- 13.24 All doors except for toilet shall have 100mm 6 lever CP Brass mortice lock . Anodized aluminum handles of ISI marked and approved size shall be provided for all doors and windows as per requirement and instruction of E.I.C.
- 13.25 Cylindrical keyless lock of 25 mm diameter and 50mm diameter knob on both sides (ISI marked) shall be provided for toilets.
- 13.26 Kitchen door shall have 250x16mm C.P. brass sliding door bolt.
- 13.27 Door shall be provided with anodized aluminum tower bolt (barrel type) 250x10mm wherever door closers are not provided.
- 13.28 All windows shall have aluminum tower bolt (barrel type) 150x10mm as per requirement.
- 13.29 Double action hydraulic floor spring of approved brand and manufacture confirming to IS: 6315 having brand logo embossed on the body/plate with double spring mechanism and door weight upto 125 kg, for doors shall be provided and fixed at the following door including cost of cutting floors as required, embedding in floors and cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer-in-charge. With stainless steel cover plate minimum 1.25 mm thickness.
- a. Main Entrance to Control Room Building / Transit Camp
 - b. Control Room
- 13.30 Aluminium extruded section body tubular type universal hydraulic door closer (having brand logo with ISI, IS : 3564, embossed on the body) with double speed adjustment with necessary accessories and screws etc. complete
- b. Substation In charge room.
 - c. Conference Room
 - d. bedroom and toilet doors of transit camp
 - e. Pantry and Kitchen
- 13.31 Plinth protection 50 mm thick of cement concrete 1:2:4 (1 cement : 2 fine aggregate : 4 graded stone) aggregate 20 mm nominal size) shall be laid over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and shall be grouted with fine sand including finishing the top smooth. Minimum width of plinth protection shall be 1000 mm.
- 13.32 G.S. corrugated sheets of 0.80 mm thick with zinc coating not less than 275 gm/m² roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8mm diameter G, I plain and bitumen washers complete excluding the cost of purlins, rafters and trusses for water tank.

- 13.33 Cement Jali of (1:2:4) (1 Cement: 2 fine aggregate : 4 coarse aggregate) 50mm thick, shall be reinforced with 1.6mm dia with Mild steel wire including centering and shuttering cleaning fixing and furnishing with cement mortar 1:3).
- 13.34 Ward Robes of required height and about 600 mm deep shall be made out of 18 mm. thk anti termite treated commercial board ISI marked at end verticals, top and bottom, shutters, partition etc complete. The rear side of the unit shall be made with 6mm thk commercial ply ISI marked, which shall have French spirit polish on the exterior face. Inner surface of the storage cabinet shall be finished with 0.8mm thk approved laminate. The horizontal partition shall be of removable type fixed with necessary SS fittings and hardware. All external surfaces shall be finished with 4.0 mm thk approved veneer with melamine including making necessary grooves, teak wood moulding as per approved drawings. Each shutter shall have piano type stainless steel hinges and C.P. Brass or SS 125mm long handle. The unit shall have necessary fittings such as tower bolts, 4 lever CB locks etc complete.
- 13.35 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.
- 13.36 Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

14.0 EXTERNAL WATER SUPPLY FROM BORE-WELL TO FIRE WATER TANK/CONTROL BUILDING AND / OR TRANSIT CAMP:

- 14.1 The drawing for the water supply from bore-well to fire water tank shall be developed by the Contractor. Water supply will be made available to the Contractor from a bore-well by the Employer at any one location within the sub-station. 80 mm dia CPVC pipe shall be provided by the Contractor from the bore-well to the fire water tank. The underground pipe line shall be laid as per CPWD Specification. The ball valve, NRV etc. shall be provided as per requirement. From this pipe line a 25 mm dia tap off shall be connected by the Contractor to the roof water tank provided for the control room building & transit camp.
- 14.2 The Contractor shall carry out all the external plumbing/erection works required for supply of water to the control room building, firewater tank and/ or transit camp beyond the single point as given at 14.1.
- 14.3 A scheme shall be prepared by the Contractor indicating the layout and details of water supply which shall be got approved from the Employer before actual start of work including

all other incidental items not shown or specified but as may be required for complete performance of the works.

14.4 Bore well is not in the scope of Contractor.

15.0 SUBMISSION:

The following information shall be submitted for review and approval to the Employer:

15.1 Editable Soft as well as hard copies of structural design calculations and structural drawings (including construction/fabrication) for all reinforced concrete and structural steel structures.

15.2 Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall identify the major building components. Auto cad drawings shall also be submitted.

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

15.4 Product information of building components and materials, including walls partition flooring ceiling, roofing, door and windows and building finishes to be submitted to EIC.

15.5 A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

16.0 MISCELLANEOUS REQUIREMENTS:

16.1 All joints including construction and expansion joints for the water retaining structures (RCC tank for Fire Fighting and underground water tank) shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

16.2 All mild steel parts used in the firefighting water tank and underground water tank shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with IS:2628 and IS:2633. Galvanizing shall be checked and tested in accordance with IS: 2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416. The structural steel provided for roofing shall have enamel paint of approved shade two or more coat to give even shade over steel primer.

- 16.3 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.
- 16.4 For sump pit of switch yard Horizontal type submersible type pump as per BOQ rating having level switch shall be provided.
- 16.5 The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan attached with this document which is available on POWERGRID web site. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification.
- 16.6 Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.
- 16.7 **CABLE TRANSIT SYSTEM**
Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete bay kiosks/switchyard panel room & control rooms in the substations. Cable transit system shall consist of multi-diameter type peel-able/adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression single piece wedge with galvanized steel bolts shall be used. 30% spare blocks of all sizes on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.
- 16.8 For communication Room GI Pipe of 40 mm dia shall be laid below floor to extend communication cable coming from switchyard via ACDB/DCDB Room.

17.0 INTERFACING:

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

18.0 STATUTORY RULES:

- 18.1 Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.
- 18.2 Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.
- 18.3 Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation. In case sulphate resistant cement is used as per requirement, differential cost between sulphate resistant cement and PPC cement shall be payable as an extra item.
- 18.4 All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.
- 18.5 All tests as required in the standard field quality plans have to be carried out without any financial implication to employer.

19.0 SPECIFICATION FOR SITE LEVELLING WORK

19.1 SCOPE OF WORK AND GENERAL CONDITION

This specification shall apply to site levelling works as are required to be executed under the Contract or otherwise directed by the Engineer-in-Charge. All testing shall be carried out as per standard field quality plan of POWERGRID.

Site levelling work shall consist of clearance of site, excavation in all kinds of soils, soft/disintegrated rock, hard rock, dewatering, transporting of excavated earth, filling, consolidation of earth, levelling benching, giving slopes and making formations, levelling operations, removal and satisfactory disposal of unsuitable materials necessary for achieving desired formation level, if required, in accordance with the requirements of the specifications and the lines, grades and cross-sections shown in the drawings or indicated by the Engineer-in-Charge. The work shall include the hauling and stacking of or the hauling to levelling site, of suitable materials as required, as also the disposal of unsuitable materials in specified manner; and the trimming and finishing of works.

This work also includes cutting of diversion channel to prevent the area from flooding and construction of kuchcha surface drains for drainage of the area.

The quality of work and materials shall comply with the requirements set forth in the succeeding sections. Where the drawings and Specifications describe a portion of the work only in general terms, and not in complete details, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer-in-Charge are to be fully complied with.

The work to be performed under this specifications consists of providing all labour, supervision, materials, planking and strutting, power, fuel, construction equipments, tools and plants, supplies, transportation, blasting materials if required, storage, insurance, royalty and all incidental items not shown or specified by reasonably implied or necessary for successful completion of work including contractor's supervision and in strict accordance with drawing and specifications.

The scope may however vary based on the specific requirement of various works/site, which shall be specified by the Owner.

The work shall be executed according to "Released for Construction", drawings with additions, alterations and modifications made from time to time as required or approved by the Engineer-in-Charge and also according to any other drawings that would be supplied to the Contractor progressively during the execution of the Contract.

Construction traffic shall not use the levelled area without prior permission of the Engineer-in-Charge. Any damage arising out of such use shall be made good by the Contractor at his own expense.

The words like Contract, Contractor, Engineer-in-Charge, Drawings, Owner, works, site used in this Specifications shall be considered to have the meaning as understood from the definition of these terms included in the General Conditions of Contract.

19.2 PRESERVATION OF PROPERTY/AMENITY:

The Contractor shall undertake all reasonable precautions for the protection and preservation of Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers or other subsurface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer-in-Charge shall be continued in use without any change.

The Contractor shall provide and install at his own expenses, suitable safeguards approved by the Engineer-in-Charge for this purpose. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition without any financial implication to POWERGRID.

19.3 DISPOSAL OF MATERIALS:

All materials arising from jungle clearing, grubbing operation, all type of excavation etc. shall be the property of Power Grid and shall be disposed of by the Contractor as hereinafter provided or directed by the Engineer-in-Charge within a lead of 2000 m beyond the periphery of substation area. Also boulders, stones and other materials usable shall be neatly stacked.

All products of clearing and grubbing which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be cleared away to waste areas and burnt, if so desired, at locations away to a lead mentioned above in a manner as directed. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for filling.

Where the excavated material is directed to be used in the filling area, it shall be directly deposited at the required location complying with the total requirements. All disposed material other than hard material shall be spread in layers at the places within specified leads.

All hard materials, such as hard moorum, rubble, etc., not intended for use in the filling, shall be stacked neatly on POWERGRID land as directed by the Engineer-in-Charge, for future use.

Unsuitable and surplus materials not intended for use in any part of the works shall be disposed off.

19.4 SITE CLEARANCE

The work shall consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engineer-in-Charge are unsuitable for incorporation in the works, from within the limits and areas as may be specified by the Engineer-in-Charge.

All trees up to a girth (perimeter) of 30 cm measured at one metre above the ground level shall also be cut and useful portion of the trees so cut shall be stacked at a suitable place as directed by the Engineer-in-Charge and shall be considered incidental to clearing and grubbing operations.

The roots of trees shall be dug up to 60 cm below the ground level or 15 cm below formation level whichever is deeper and after removal of all vegetable and organic matter from the holes so formed by removal of the roots, holes and hollows shall be filled with good earth in layer of 20 cm, well rammed, consolidated and levelled.

The serviceable and unserviceable materials obtained from the site clearance shall be removed from the area and disposed of to a place as per the directions of the Engineer-in-Charge. All unserviceable and serviceable materials obtained from the site clearance shall be the property of POWERGRID.

Clearing and grubbing item is not payable and the same shall be deemed to be included in the earth work in excavation and filling.

Trees having girth above 30 cm are not in the scope of Contractor.

19.5 CLASSIFICATION OF EXCAVATED MATERIALS:

All materials involved in excavation shall be classified in the following groups:

19.5.1 ALL KIND OF SOILS AND SOFT/DISINTEGRATED ROCK

The material which can be quarried/excavated with pick, shovels, jumpers, scarifiers, crowbars etc. and other mechanical implements. All materials involved under this classification are as below:

All kind of soils includes various types of soils, plain concrete, shingle and river or nallah bed boulders, soling of road, paths and hard core, macadam surface of any description, stone masonry below the ground level, soft conglomerate and laterite stone which can be detached from the matrix with picks and shovel.

Soft/disintegrated Rock (Not requiring blasting): Rock and boulders which may be quarried and split with crow bars and other mechanical implements etc. It includes lime stone, sand stone, hard conglomerate.

19.5.2 HARD ROCK:

All kind of rocks which can be excavated by machines and requires blasting chiselling in edging or in another agreed method. This can be classified under the following categories:

a) Hard Rock (Requiring Blasting)-This shall comprise:

- i) Any rock for the excavation of which the use of mechanical plant or blasting is required;
- ii) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground; and
- iii) Boulder requiring blasting.

b) Hard Rock (Blasting Prohibited)

Hard rock requiring blasting as described under (a) above but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

19.5.3 AUTHORITY FOR CLASSIFICATION EXCAVATION:

The classification of excavation shall be decided by the Engineer-in-Charge and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-Charge. All the excavated material shall be the property of the POWERGRID.

19.6 SITE LEVELLING OPERATIONS:

19.6.1 SETTING OUT AND MARKING PROFILES.

After the site has been cleared, the limits of site levelling shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-Charge. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and establishment of bench marks. A grid system of co-ordinates shall be established by the Contractor at the site. The Contractor shall be responsible for the maintenance of permanent reference pillars, bench marks and other marks and stakes as long as in the opinion of the Engineer-in-Charge they are required for the work. All such marks/pillars shall be removed by the Contractor at his own cost as soon as the purpose is over.

Masonry pillars shall be erected at suitable places in the area to serve as bench marks for the execution of the work. These bench marks shall be connected with G.T.S. of any other permanent bench mark approved by the Engineer-in-Charge. Necessary profiles with pegs, bamboos and strings or "Burgeis" shall be made to show the correct formation levels before the work is started and the same shall be approved by the Engineer-in-Charge. The contractor shall supply all labour, tools, equipment, materials, safeguards and incidentals necessary for setting out and making profiles and burgeis & pillars for the work at his own cost. The profiles and burgeis shall be maintained during the execution of the work.

Marks/pillars shall invariably be diagonal unless otherwise directed, and should be such that their average height is representative of average depths. Payments will be made on the basis of volume measurement after with-holding the amount corresponding to 5% of the volume of earth work on account of non-removal of marks/pillars.

The Contractor shall have to remove the marks/pillars and utilise the earth spoils as per the directions of the Engineer-in-Charge. The withheld amount as stated in the above paragraph

may be paid after certification of the Engineer-in-Charge; regarding his full satisfaction and to the effect that the mark/pillars, etc. have been removed and soils/earth thereof has been utilised as directed by him.

If the contractor fails to remove, partly or fully the marks/pillars in the manner and within the period as aforesaid double the amount spent by the owner for removal of marks/pillars will be recovered from dues payable to the contractor.

19.6.2 EXCAVATION AND FILLING

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer-in-Charge. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon before disposal.

While planning or executing excavation, the Contractor shall take all adequate precautions against soil erosion, water pollution, air pollution etc.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed with a negative tolerance of 100mm. The Contractor shall not excavate outside the slopes or below the established grade or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels shall be made good at the cost of the Contractor with suitable material of similar characteristics and compacted to the required density and to the satisfaction of the Engineer-in-Charge.

All debris and loose material on the slopes of cuttings shall be removed.

Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be allowed. Final surface shall be neatly dressed. The earth from cutting shall be directly used for filling and no extra claim for double handling of earth shall be admissible to the contractor.

If cutting be taken deeper, it shall be brought to the required level as per the instructions, by filling it with the earth and duly consolidating at the Contractor's cost.

Filling shall be done in regular horizontal layers not exceeding 20 cm. in depth. The earth shall be free from all roots, grass, rubbish and humps and clods exceeding 80mm in any direction shall be broken. Each layer shall be consolidated by breaking clods and Compacting each layer with wooden /steel rammer or movement of dozers, trucks or 8/10 tonne power road rollers, sheep foot roller and vibratory compactors etc. so that compaction of 95% of the maximum dry density is achieved at optimum moisture content. The surface finished shall be neatly dressed to the required formation levels with tolerance of (\pm) 100 mm.

Tests for Compaction are to be performed as per the procedures laid down in the relevant I.S. Codes of practice and Standard Field Quality Plan of POWERGRID. In cases of compaction below the stipulated percentage, the contractor shall adopt proper techniques as directed by the Engineer in-Charge and to his satisfaction to ensure the specified degree of compaction. The cost of tests to be performed shall be borne by the Contractor.

During the execution of work, natural drainage of the area shall be maintained by the contractor.

19.6.3 HARD ROCK EXCAVATION

Hard Rock, when encountered during excavation, shall be removed up to the finished ground level or as indicated on the drawings. In all cases, the excavation operations shall be so carried out that at no point on cut formation the rock protrudes above the specified levels, provided, however, that a negative tolerance of 150 mm shall be permissible.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer-in-Charge. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when prised by a crowbar shall be removed.

Blasting shall be carried out as per relevant clause mentioned elsewhere in this specification and all precautions indicated therein to be observed.

19.6.4 DEWATERING

If water is met with in the excavation due to stream flows, springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and other excavation kept dry whenever so required or directed by the Engineer-in-Charge, Care shall be taken to so discharge the drained water as not to cause damage to the works, crops or any other property. No extra payment shall be admissible to the contractor on this account.

19.6.5 FINISHING OPERATIONS

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces. When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock where no point shall vary more than 600 mm from the designated slope. In no case shall any portion of the slope encroach on the road way.

19.7 EARTH FILL MATERIAL:

19.7.1 SUITABLE MATERIAL

The borrowed earth used in filling shall be free from all roots, grass, shrubs, rank vegetation, brush wood, tree sapling and rubbish.

19.7.2 UNSUITABLE MATERIAL

Unsuitable material shall mean materials unsuitable for placing as fill in the works and shall comprise:

- a) Material from swamps, marshes and bogs;
- b) Peat, logs, stumps and perishable materials;
- c) Material susceptible to spontaneous combustion;
- d) Any natural material or industrial and domestic produce which will adversely affect other materials in the work;
- e) Clay with liquid limit exceeding 80% and/or plasticity index exceeding 55%.

19.7.3 SPREADING AND COMPACTION OF FILLING

For the earth works contractor shall satisfy the Engineer-in-Charge that the entire specified requirement regarding compaction can be achieved. Testing shall be carried out as per standard field quality plan of POWERGRID.

The Final formation shall be correct in level and profile after compaction.

In the case of earth work consolidated under optimum moisture conditions, each layer of earth shall be carefully moistened to give field moisture content of about + 1% to - 2% of the optimum moisture content (OMC). The OMC shall be determined according to IS: 2720 (Pt.VII &VIII) Methods of Tests for Soils.

Each layer shall then be compacted by rolling with wooden/ steel rammer or movement of dozers, trucks, 8/10 tonnes power road roller, sheep foot roller and vibratory compactors/roller. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent pounding.

19.8 BLASTING OPERATIONS.

19.8.1 GENERAL

Blasting shall be carried out only with the written permission of the Engineer-in-Charge. All the statutory laws, regulations, rules, Indian Standards, etc., pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements, after approval from the Engineer-in-Charge and shall muffle the blasting adequately to the satisfaction of the Engineer-in-Charge. Blasting should be carried out as far as possible with the help of Ammonium Nitrate mixed with proper proportions of fuel oil which is a safer method. However, in the event of its nonavailability the convenient practice of using gelatine with detonators can be resorted to.

The magazine for the storage of explosives shall be built to the designs and specifications of the Explosives Department concerned and located at the approved site. No unauthorised person shall be admitted into the magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be hung in the lobby of the magazine.

- a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar,
- b) A statement of up to date stock in the magazine,
- c) A certificate showing the last date of testing of the lightning conductor,
- d) A notice that smoking is strictly prohibited.

In addition to these, the Contractor shall also observe the instructions in following clauses and any further additional instructions which may be given by the Engineer-in-Charge and shall be responsible for damage to property and any accident which may occur to workmen or the public or the materials on account of any operations and blasting. The Engineer-in-Charge shall frequently check the Contractor's compliance with these precautions.

19.8.2 MATERIALS, TOOLS AND EQUIPMENT.

All the materials, tools and equipment used for blasting operations shall be of approved type and shall be arranged by the contractor from any authorised dealer of such approved material. Necessary assistance in the form of approval for procurement of the material shall be given by the Corporation. The contractor shall be fully responsible for entering into the agreement with any authorised magazine contractor in respect of rates, regularity of supply, etc. the Engineer-in-Charge may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a safe length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators fuses, etc., shall be fresh and not damaged due to damp, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed immediately.

19.8.3 PERSONNEL

The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

19.8.4 BLASTING OPERATIONS.

The blasting shall be carried out during fixed hours of the day preferably during the midday lunch hour or at the close of the work as ordered in writing by the Engineer-in-Charge. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only. Proper precautions for safety of persons and property shall be taken.

Red danger flags shall be displayed prominently in all directions during the blasting operations. People, except those who actually light the fuse shall be prohibited from entering this area. The flags shall be planted 200 metres from the blasting site in all directions and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning whistle being sounded for the purpose. The charge holes shall be drilled to required depths and in suitable places. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a whistle in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man in charge only. The man in charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site.

When blasting is to be carried out in the proximity of other existing structures, sand/earth bags, etc. shall be used on the top of the blast holes to prevent the rock fragment from causing damage to the structures.

However, when blasting is prohibited for any reasons the excavation shall be carried out by chiselling, wedging or any other agreed method.

19.8.5 MISFIRE

In case of misfire, the following procedure shall be observed:

- i) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.
- ii) If it is the blasting powder charge it shall be completely flooded with water. A new hole shall be drilled at about 45 cm. from the old hole and fired. This should blast the old charge. Should it not blast the old, the procedure shall be repeated till the old charge is blasted.
- iii) If a misfire has been found to be due to defective detonator, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer-in-Charge for inspection to ascertain whether all the remaining materials in the box are also defective.

19.8.6 ACCOUNT.

A careful and day to day account of the explosives shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer-in-Charge at all times.

19.9 RECORDING OF MEASUREMENTS

The ground levels shall be taken at every 5 metres distance and at closer distances where pits, undulations, etc. are met with. The ground level shall be recorded in field book, plotted on plans and shall be signed by contractor and the Engineer-in-Charge before the earth work is started.

The levels of the area after excavation shall be recorded in the field book duly signed by the Engineer-in-Charge and contractor. The labour, materials, tools, equipment, safeguards and incidentals required for taking levels shall be supplied by the contractor at his own cost.

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

- | | |
|---------------------------------------|--------------------------|
| a) Length and breadth | -- 10 mm |
| b) Height, depth or thickness of work | -- 5 mm |
| c) Area | -- two places of decimal |
| d) Cubical qty. | -- two places of decimal |

20.0 MODE OF MEASUREMENT

Mode of measurement for different items is given below, however, in case of any ambiguity relevant part of IS: 1200 (latest) shall be referred.

20.1 EARTHWORK

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling, compacting, dewatering (if required) and disposal of surplus earth/ rock to a suitable location within a lead up to two km. Excavation or dismantling of lean concrete shall be measured under this item. The quantity of excavation for foundations of towers, equipment structures, all transformers, firewall, cable trenches, water tank, reactors, buildings, marshalling kiosks, underground water tanks and covered car parking shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including fixing of lamp posts/ electric poles, plinth protection, flooring, sewerage system, manholes, pipes, earth mat, pipe support etc. shall also not be paid for. The measurement of excavation for all concrete works shall be made considering dimension of the pit keeping 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

The quantity shall be measured in cubic meters as per following details:

- a) Excavation in all kind of soil including soft/ disintegrated rock, PCC, WBM, Brickwork/ stone masonry etc (excluding hard rock).
- b) Excavation in hard rock (required blasting)

20.2 PLAIN CEMENT CONCRETE (PCC)

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

20.2.1 PCC 1:2:4 (1 cement : 2 fine aggregate : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer foundation, reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, gate etc. as indicated in the drawings.

20.2.2 PCC 1:3:6 (1 cement : 3 fine aggregate : 6 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor

foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.

20.2.3 PCC 1:4:8 (1 cement : 4 fine aggregate : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.

20.2.4 PCC 1:5:10 (1 cement: 5 fine aggregate: 10 brick aggregate/ stone aggregate 40mm nominal size) shall be provided for site surfacing in switchyard. This shall include providing and laying cement slurry in case of site surfacing in switchyard.

All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits, water proofing of roof etc. shall not be measured and deemed to be included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

20.3 RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning. This shall also include pre-cast RCC work and addition of water proofing compound & admixtures wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 sq.m.

20.4 REINFORCEMENT STEEL

Reinforcement shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tons on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

20.5 STONE FILLING

Measurement of stone (40-60mm size) for transformer/ reactor foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per drawings. This shall be measured in cu.m. no voids shall be deducted.

20.6 MISCELLANEOUS STRUCTURAL STEEL

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for mono rails (RS joists), rails for transformers/ reactors, trusses, frame work, purlins, gratings including factory made electro forged gratings, steel tubes, built up sections along with all other steel fittings and fixtures, inserts and embedment in concrete shall be made as per drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre- heating of the welded joints, applying a priming coat of steel primer / anti corrosive bitumastic paint/ synthetic enamel paint etc. wherever specified (For gratings and its supports epoxy zinc phosphate primmer shall be used) setting of all types of embedment in concrete, etc. Steel required for foundation bolts & fasteners (other than towers and equipment support structures), doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment's required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, steel structures of PEB buildings, etc. shall not be considered for payment and measurements. Quantity shall be measured in MT.

20.7 ROADS

20.7.1 The measurement for the concrete road shall be made on the basis of area in square meter (M^2) of top concrete completed surface of the road and shall be deemed to include all items such as earth work (excavation, disposal etc.), compaction, rolling, watering, WBM, Kerb stone, grating, shoulder, 100mm dia RCC Hume pipe to be provided at every 100M etc where ever indicated complete as per drawing. Concreting all type and reinforcement shall be measured and paid separately under relevant items mentioned else where in this specification. Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.7.2 The measurement of bituminous road shall be made on the basis of area in square meter (M^2), of the top bituminous completed surface of the road and shall include all items such as earth work (excavation, disposal etc.), compaction, rolling, watering, WBM, Kerb stone, grating, shoulder, 100mm dia RCC Hume pipe to be provided at every 100M etc where ever indicated complete as per drawing including premix carpet etc complete .Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.7.3 Interlocking concrete tiles required to be provided on the shoulders of the road shall be measured in square meter (M^2) and paid separately under relevant item.

20.8 ANTIWEED TREATMENT

The measurement shall be done for the actual area in square metres of antiweed treatment which will include supplying required chemicals and doing the treatment complete in all respect as per the specification for the specified area.

20.9 STONE SPREADING IN SWITCHYARD

The measurement shall be done for the actual area in square meters of stone spreading in the switchyard which will include supplying and laying of 100mm thickness of stone aggregate as per specification for the specified area.

20.10 CHAIN LINK FENCING AND GATE

The measurement shall be made in running metres of the fence provided as per drawing. The rate shall be inclusive of post, wire mesh, MS Flat etc. complete. All concrete shall be measured and paid under relevant item. The gate shall be measured in numbers.

20.11 CABLE TRENCH CROSSING AND ROAD CULVERTS THROUGH HUME PIPES

Cable trench crossings and road culverts shall be measured by length (in running meters) of individual Hume pipe which will be laid as per the drawings. The item shall be inclusive of earth work (excavation, backfilling, disposal etc.), laying, back filling, jointing, brickwork, plastering etc complete in all respect but excluding concrete (all type) which will be measured and paid separately under respective items.

20.12 BUILDINGS:

20.12.1 RCC FRAMED STRUCTURE BUILDINGS:

Payment for item shall be made on plinth area basis. However, the quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel shall be measured and paid as per relevant clauses as described above. The rest of the entire work (including internal & external finishing), stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawings furnished by the Employer shall be deemed to be included in the plinth area rate. Plinth area shall be calculated based on IS 3861-2002.

20.12.2 PRE-ENGINEERED STEEL BUILDINGS:

- a) GIS HALL
- b) AHU & RELAY ROOM

The quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel shall be measured & paid separately as per relevant clauses as

described above. Plinth area shall be calculated based on IS 3861-2002. However, payment for remaining finishing items a), b) & c) shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system, miscellaneous structural steel required for seating of GIS equipments, cable supports in cable trenches, chequered plates etc inside GIS building. complete in all respect.

20.12.3 EXTENSION OF RCC /PEB BUILDINGS:

- a) CONTROL ROOM BUILDING
- b) GIS HALL
- c) AHU & RELAY ROOM

The quantity of earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement shall be measured and paid as per relevant clauses as described above. Plinth area shall be calculated based on IS 3861-2002. However, payment for above items a), b) & c) shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit & junction boxes, fan boxes, cable transit system wall dismantling works, miscellaneous structural steel required for seating of GIS equipments, cable supports in cable trenches, chequered plates etc inside GIS building complete in all respect.

20.12.4 INTERNAL ELECTRIFICATION AND FIRE FIGHTING:

Payment for internal electrification as well as internal firefighting works is not included in items covered in clauses above and shall be paid as per relevant clauses and BPS. However, conduit, junction boxes, surface boxes for electrification, cable transit system is deemed to be included in the building items.

20.13 RAIN WATER HARVESTING

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including earth work (excavation, backfilling, disposal etc.), miscellaneous steel, brick work, fillings of boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the relevant clauses as mentioned above.

20.14 RAIL CUM ROAD

The measurement for the rail cum road shall be made in square metres of top concrete completed surface of the rail cum road and shall include all items such as earth work (excavation, backfilling, disposal etc.), compaction, rolling, watering, WBM etc. complete as per drawing but excluding concrete (all type), reinforcement, structural steel and rails. Usage of WMM in place of WBM shall be done with approval of employer without any additional financial implication.

20.15 SEPTIC TANK AND SOAK PIT

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the clause including earth work (excavation, backfilling, disposal etc.), masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the relevant clauses mentioned above.

20.16 FIRE WATER TANK

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including, compaction, brick work, roof truss, purlins, roofing, all types of miscellaneous steel, internal and external plastering, painting etc. shall be deemed to be included in this lump sum cost. However, concrete (all types) and reinforcement shall be measured and paid under the relevant clauses as mentioned above.

20.17 EXTERNAL WATER SUPPLY FROM BORE-WELL TO FIRE WATER TANK, CONTROL ROOM BUILDING AND TRANSIT CAMP:

The external water supply from Bore-well shall be measured in running meters of pipe of various diameters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

20.18 EXTERNAL SEWERAGE :

Sewage System of the shall be measured diameter wise in running meters. It shall include all the items such as earth work (excavation, backfilling, disposal etc.), piping, pipe fittings, manholes, gully trap, gully chamber, encasing in concrete and repairs etc required to complete the job. Any modification in the existing sewage system, if required, shall be done by the Contractor without any financial implication to Employer.

20.19 CABLE TRENCHES:

Various items like earth work (excavation, backfilling, disposal etc.), concrete (all type), reinforcement steel and miscellaneous steel required for construction of cable trenches shall be measured and paid under respective clauses mentioned above.

20.20 DRAINS:

The item Concrete (all type) & Reinforcement for drains shall be measured under relevant clauses as mentioned above. All other items required for completion of drains shall be deemed to be included in the rate of items quoted for the drain. The quantity for each type of drain section shall be measured in meters along the centre line of drain.

20.21 SOIL TREATMENT :

CNS or sand filling or boulder packing with interstices filled with sand under or sides of the foundations, roads, cable trenches, drains etc shall be measured in cubic meters.

20.22 PILE FOUNDATION:

20.22.1 For payment purpose pile of different diameter shall be measured separately in length (running meter) from bottom of pile cap to the lowest point of pile. The rate shall include boring, providing and installation including temporary casing as applicable etc. complete in all respect except for concrete and reinforcement steel which will be paid separately under relevant items of BPS. Initial and routine test for vertical load and lateral load shall be payable under respective items of BPS.

20.22.2 In case pile foundation is not envisaged originally in the LOA then concrete and reinforcement steel shall be measured and paid as per items mentioned under relevant clauses as mentioned above. Boring installation including temporary casing, bentonite treatment, initial and routine tests etc of pile will be paid as an extra item. In case extra quantity of cement is required to meet the provisions of IS: 2911, it will be paid as an extra item.

20.23 CONTRACTOR DESIGNED FOUNDATIONS: Contractor designed foundations shall be measured {quantity of earth work (excavation, backfilling, disposal etc.), PCC, RCC, reinforcement} and paid as per relevant clauses as mentioned above, unless otherwise specified.

20.24 Billing break up of Lump sum items for payment purpose shall be decided at site by Engineer in charge for the work.

20.25 Civil works for Pipe supports and deluge valve housing for firefighting shall be deemed to be included in the items for firefighting and shall not be paid under civil works.

20.26 BOUNDARY WALL:

The measurements of boundary wall shall be in running meter of finished work. The rate shall be inclusive of earth work (excavation, backfilling, disposal etc.), concrete (all type), Reinforcement, MS steel, brick masonry, plastering barbed wire/ concertina coil, painting etc. complete required for completion of boundary wall. Nothing extra shall be payable on this account.

20.27 SITE LEVELLING:

20.27.1 EARTH WORK IN EXCAVATION AND FILLING

The quantity of excavation in all types of soil and soft/disintegrated rock shall be worked out by using initial and final levels. No void deduction shall be made to calculate net quantity of earth work. Only Excavation/cutting will be measured for payment purpose. The unit of measurement shall be in cubic metre.

In case hard rock is encountered during excavation, the level of rock surface before start and completion of rock excavation shall be recorded for calculating the quantity of excavation of hard rock. The volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50 % deduction for voids. The item of excavation in hard rock shall be payable separately.

The quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity.

The unit rate shall include all lifts and all leads within levelling boundary. It also includes disposal of surplus earth and stacking of unusable material up the lead of 2000 meters beyond the levelling boundary. Rate of item shall include all operations specified in the respective clause of technical specification.

20.27.2 EARTH WORKS IN EXCAVATION IN ALL TYPES OF SOILS AND SOFT /DISINTEGRATED ROCKS, HARD ROCKS AND DISPOSAL.

Quantity of excavation in all type of soils and soft/disintegrated rocks shall be worked out based on initial level before start of excavation and final levels after excavation. No void deduction shall be made to calculate net quantity of earth work in excavation. The excavated soil and soft/disintegrated rock shall be used for filling in lower areas of the substation. The unit rate shall include disposal of excavated material for leads up to 1000 meters beyond the levelling boundary.

For hard rock excavation, the volume of hard rock shall be computed on the basis of stacks of excavated rubble after making 50% deduction for voids. The unit of measurement shall be in cubic meter. The unit rate shall include stacking, disposal of excavated material for leads up to 2000 meters beyond the levelling boundary.

Where soil, soft/disintegrated rock and hard rock are mixed, the quantity of earth work in excavation in all kinds of soil & soft/disintegrated rock shall be arrived by reducing quantity of hard rock from the gross excavated quantity. Rate of item shall include all operations specified in the respective clause of technical specification.

20.27.3 FILLING USING EARTH BORROWED FROM OUTSIDE THE SUBSTATION LAND

For borrowed earth, the measurement shall be based on levels of area under filling only. The quantity of earth shall be worked out based on initial and final levels of levelling area. No void deduction shall be made to calculate net quantity of earth work. The unit of measurement shall be in cubic meter. The rate shall include arrangement of borrow area, payment of royalty, transportation, laying compaction, all leads and lifts etc. Rate of item shall include all operations specified in the respective clause of technical specification.

STRUCTURE

Table of contents

Clause No.	Description	Page No.
1.0	GENERAL	1
2.0	DESIGN REQUIREMENTS FOR STRUCTURES NOT COVERED IN STANDARDISED LIST	2
3.0	DESIGN DRAWINGS, BILL OF MATETRIALS AND DOCUMENTS	4
4.0	FABRICATION AND ERECTION	5
5.0	BOLTING	5
6.0	WELDING	5
7.0	FOUNDATION BOLTS	6
8.0	STABILITY OF STRUCTURE	6
9.0	GROUTING	6
10.0	GALVANISING	6
11.0	TOUCH-UP PAINTING	6
12.0	INSPECTION BEFORE DISPATCH	7
13.0	TEST CERTIFICATE	7
14.0	SAFETY PRECAUTIONS	7

SECTION: STRUCTURES

1.0 GENERAL

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanised steel structures for towers, beams, lightning masts and equipment support structures. If specified in section – Project, design of steel structure shall also be in the scope of contractor. The structures shall be of pipe type or lattice type as per Bid Proposa Sheet. Lattice structures shall be fabricated from structural steel conforming to IS: 2062 (latest). All pipe structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806.

Line diagrams of Towers, beams, Lightning masts, equipment support structures are enclosed with the tender document. The fabrication drawings along with BOMs for these structures shall be provided to the successful bidder after the award. However structure, which are to be designed at detailed engineering stage by the employer, only line diagram shall be provided by POWERGRID and fabrication drawing shall be prepared by the Contractor. Support structure for circuit breaker shall be designed by the Manufacturer. Any other structure necessary to suit the layout for a particular substation to complete the work in all respect shall be designed by the employer / contractor at detailed Engineering stage.

Equipment support structure standardization has been carried out by the employer with the provision of stool to facilitate interchangeability of equipments at a later stage. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m. Zinc coating for costal areas, if defined in section – Project shall not be less than 900gm/sq.m

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box,

surge counter, etc. in the standard structure fabrication drawings. Nothing extra shall be payable or recoverable from the contractor on account of modification in support structures.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES (To be referred only for structures to be designed by the Contractor)

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875,Parts I to V.

2.2 For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.

2.3 Minimum thickness of galvanized tower member shall be as follows:

Members	Minimum thickness (mm)
Leg members, Ground wire	
Peak members/Main members	5
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 Step Bolts

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

2.8 Design Criteria

- a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63kA or as applicable. IEC-60865 may be followed for evaluation of short circuit forces.
- b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered for the design of switchyard structures.
- c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.
- d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 9 metric tonnes per phase for 765kV, 4 metric tonnes per phase for 400kV, 2 metric tonnes per phase for 220kV and 1 metric tonne per phase for 132 kV or as per requirements whichever is higher . The distance between terminal gantry and dead end tower shall be taken as 200 metres for 765/400/220kV and 100m for 132KV. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.
- e) The beams shall be connected with towers/ columns by bolted joints.
- f) All Pipe support structures used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS: 1161 read in conjunction with IS: 806.
- g) If luminaries are proposed to be fixed on gantries, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.
- h) Foundation bolts shall be designed for the loads for which the structures are designed.

- i) Height of Lightning masts shall be as per approved structure layout and designed for diagonal wind condition. Lightning masts shall be provided with platforms for mounting lighting fixtures and a structural steel ladder within its base up to the level of platform. The ladder shall be provided with protection rings. The platforms shall also have protection railing. The details of lighting fixtures would be as per the approved drawings.

3.0 DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

- 3.1 Structures, for which line diagram has already been provided along with tender documents, fabrication drawings (structure assembly drawing) along with Bill of Material shall be provided to the successful bidder after award based on which structures shall be supplied. Fabrication drawings issued to the contractor for any project shall be valid for other projects also if wind speed of the area is same. These drawings are also available on the POWERGRID web site and can be downloaded from the web site. Hard copies, if needed, can be obtained from employer. These drawings shall be good for fabrication and inspection of steel structures for any substation. Release for construction stamp for particular substation is not required. Replacing MS section with higher section or replacing MS section with HT section of same size due to non availability of particular section shall not require employer's approval and this can be done without any additional financial implication to the employer.

3.2 STRUCTURES DESIGNED DURING DETAILED ENGINEERING:

- 3.2.1 In case design of structure is to be done by employer, only line diagram of the structure shall be provided to the contractor and fabrication drawing shall be prepared by contractor based on line diagram and submitted for approval.
- 3.2.2 In case design of structure is covered in the scope of contract, the contractor shall submit design alongwith line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employers' approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.
- 3.2.3 The fabrication drawings to be prepared and furnished by the Contractor shall be based on line diagram provided by employer or the design approved by the employer. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.

- 3.3 Such approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.0 FABRICATION AND ERECTION

- 4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.
- 4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.
- 4.3 Sample towers, beams, lightning masts and equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.
- 4.4 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification, if any, required during erection shall be done at site with the approval of Engineer – in- charge.

5.0 BOLTING

- i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- ii) In case of fasteners, the galvanizing shall conform to IS-1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS-1573.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be

according to IS:813. Welding shall be carried out in accordance with IS:816.

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

7.4 All foundation bolts shall be provided with two no. standard nuts of class 5 confirming to IS:1363/1367/6639, one check nut of class 4 confirming to IS:1364, one ancore plate at the bottom of foundation bolt and one plain washer.

7.5 All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062/ SAE:1018.

8.0 STABILITY OF STRUCTURE

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

10.0 GALVANISING

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4579. Purity of zinc to be used shall be 99.95% as per IS:209.

11.0 TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying

zinc rich primer and two coats of enamel paint to the satisfaction the employer before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

14.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.

15.0 All tests mentioned in standard field quality plans shall have to be carried out and conformity of materials and workmanship shall be ascertained.

**TECHNICAL SPECIFICATION
FOR
VISUAL MONITORING SYSTEM**

Technical Specification of Visual Monitoring System

Power Grid Corporation of India Limited (POWERGRID) intends to install Visual Monitoring System (VMS) for security purposes in Battery Energy Storage Substation (BESS) environment for surveillance of the premises and other POWERGRID locations.

1. Scope

The scope of work of the Bidder shall cover following, but not limited to:

- Design, supply, erect, test and commission the complete system including cameras, Network video recorder system, Storage, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system.
- Carryout complete application engineering so as to achieve the desired objectives with the stated performance requirement.
- Provide all hardware and latest secured version of software, as necessary, to meet functional requirements of the tender.
- Any hardware, software and firmware required to meet the tender requirements shall be provided by the vendor without any time and cost implication.

System with Color IP based Fixed Cameras for VMS surveillance would be located at various locations as per site condition.

The number of cameras and their locations shall be decided in such a way that it provides detection capability with minimum detection range of 100 meter and minimum IR range of 50 meters in the premises of substation, regional offices, corporate centre, project site, and other locations.

The cameras can be mounted on structures, buildings, wall, or any other suitable mounting arrangement to avoid any blind zone. Typical architecture of VMS system is shown in Figure-1; however, the architecture may be changed as per requirement during detailed engineering and the same to be approved by Engineer-In-Charge.

2. Technical requirements of Visual Monitoring System

- 2.1. The system should facilitate viewing of live and recorded images controlling of all cameras by the authorized users.
- 2.2. The system shall use video signals from color cameras installed at different locations, process them for viewing on workstation/monitors in the specified places as per architecture.
- 2.3. The System shall provide sufficient storage of all the cameras recording for a minimum period of 15 days @ 15 FPS for cameras placed at non-critical locations, & 180 days @ 15 FPS for cameras placed at “Important / sensitive zones” at 4 CIF or better quality using necessary compression techniques for all cameras and the Bidder shall calculate the requirement of storage accordingly. It shall be insured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.
- 2.4. The Surveillance VMS system shall operate on 230V AC ($\pm 10\%$) power supply (other than Substations) and 220V DC/110V DC ($+10\%/-15\%$) (in case of Substation premises) except NVR, Storage, Client Machine placed in the control room. For VMS

Technical Specification of Visual Monitoring System

equipment's placed in the switchyard (in case of Substation premises), the power supply shall be extended from the 220V DC/ 110V DC (+10%/-15%) from nearby BMK/distribution board in the switchyard. Providing necessary MCBs to fetch the supply from BMK is in the scope of contractor.

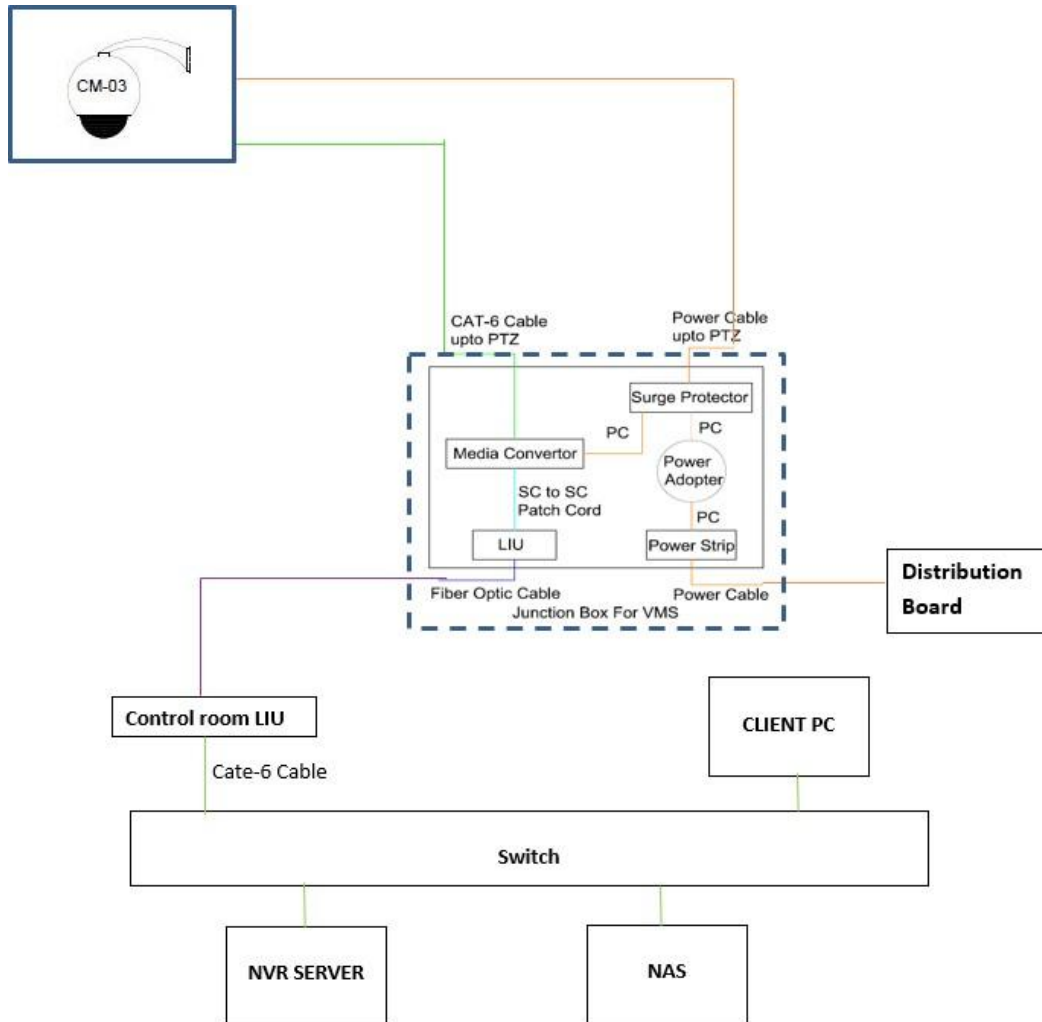


Figure 1: Typical Architecture of VMS System

3. System requirements

- 3.1. System must provide built in facility of watermarking or Digital certificate to ensure tamperproof recording.
- 3.2. All cameras may be connected through an LAN.
- 3.3. All camera recording shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, location/area of recording & date/time shall be programmable by the system administrator with Password.
- 3.4. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination should be available in the system.
- 3.5. Facility of camera recording in HD (1280x720p), D1, 4CIF, CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.

Technical Specification of Visual Monitoring System

- 3.6. In order to optimize the memory, while recording, video shall be compressed using H.265/MPEG-4 or better standard and streamed over the IP network.
- 3.7. System shall be triplex i.e. it should provide facility of simultaneously Viewing, Recording & replay.
- 3.8. The equipment should generally conform to Electromagnetic compatibility requirements.
- 3.9. The system should support time synchronization from GPS/NavIC signal through IRIG-B, RS232/485, SNTP, etc.
- 3.10. The system should also support recording and storage of event logs like user logins, settings changes, remote logins, exporting of recordings, etc.

4. VIDEO SURVEILLANCE APPLICATION SOFTWARE

- 4.1. Video surveillance application software should be capable to display and manage the entire surveillance system.
- 4.2. The software should have inbuilt facility to store configuration of cameras.
- 4.3. The software should support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.
- 4.4. The software should be able to control all cameras i.e., Iris control, auto / manual focus, and color balance of camera, Video tour selection etc.
- 4.5. The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.
- 4.6. The user should be on a hierarchical basis as assigned by the administrator.
- 4.7. It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should have the facility for scheduled recording. Different recording speeds (FPS) and resolution for each recording mode for each camera should be possible.
- 4.8. The software for clients should also be working on a browser-based system for remote users.
- 4.9. The software should be capable of integrating ONVIF compliant cameras.
- 4.10. The software should allow retrieval of data instantaneously or any date / time interval chosen through functionality of the application software. In case data is older than 15 days for cameras placed at non-critical locations and 180 days for cameras placed at "important/sensitive" locations and available, even then, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software.
- 4.11. The software should provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, and server health check reports etc.
- 4.12. The Software should record in auto FIFO (first in and first out) mode and should maintain minimum storage requirements of 15 days for cameras placed at non-critical

Technical Specification of Visual Monitoring System

locations and 180 days for cameras placed at "important/sensitive" locations at any given point of time.

5. Network Video Recorder

Function of Network Video Recorder server is to keep the VMS application along with database. The minimum configuration of Network Video Recorder shall be as detailed below:

A. Functional Requirement

1	Recording and Display frame rate	Real-time 15 frames per second per channel, manual select.
2	Recording resolution	(PAL):1280X720,704(H)X576(V)
3	Compression method	H.265/MPEG4 or Better
4	Video Motion Detection Capable	Standard and built-in (selectable in menu)
5	Monitoring options	Split screen 1,2,4,8,16,32 or more cameras
6	Playback options	Search, still image capture
7	Alarm/Event recording capable	To be provided with built-in external alarm input/output ports minimum.
8	Network operation capable	To be provided by using WAN or LAN
9	Viewing Capable from a central system.	Using WAN or LAN router
10	HDD storage consumption	As per calculation based on frame speed, resolution setting, compression (Storage shall be in NAS)
11	Operation	Triplex operation (Simultaneously Viewing, recording and replay)

B. Technical Requirements

Sr. No.	Item NVR server	Minimum Characteristics
1	General features	
a.	Processor and Clock	Processor (Latest Version), 8 cores or better, 3.0 Ghz (min.)
b.	Operating System	Windows 2025 server or Linux Redhat v9.5 or latest tested compatible with VMS application along with licensed Anti-virus. In case, the End of Life/End of Support declared for offered Operating System, the Contractor has to Upgrade to latest version prior to SAT of System.
c.	Cache	16 MB Cache
d.	RAM	32 GB memory
e.	DIMM Slots	4

Technical Specification of Visual Monitoring System

f.	Hard Disk	16 TB (minimum) capacity with Raid 5 or latest suitable configuration The NVR storage shall have an additional camera integration capacity of 25%
g.	Storage Drive	DVD +/- RW
h.	Support for both IPv4 and IPv6	Yes (Static IP)
i.	CPU core	8 Core with a GPU card (min 4 GB) or better
j.	Support SNMP v1/v2/v3	Yes
2.	Interface	
a.	I/O ports	1 x serial port, 1 x parallel port
b.	Ethernet ports	Dual 10/100/1000 Ethernet (RJ-45 port)
c.	Expansion Slots	PCIe Slots- 2nos
3.	Power Supply	Redundant (2 Ports) input Supply 230V AC (+/-10%) 50Hz
4.	Environmental aspects	
a.	Relative Humidity	+5% of climatic condition of place
5.	User Interface	
a.	Monitor	TFT 22" High resolution monitor
b.	Keyboard	Yes
c.	Mouse	Yes
d.	Speakers with Audible Alarms	external speakers
6.	Anti-Virus Support	Yes (licensed), which can be patched offline using a central system.

6. Camera Features

- 6.1. The color IP camera shall be IP type.
- 6.2. The camera at the gate shall be used for monitoring entry and exit.
- 6.3. The camera shall be suitable for wall mounting, Ceiling mounting and switchyard structure mounting.
- 6.4. The camera should be able to detect motion in day & night environments having light intensity of 0.5 Lux or better. Camera shall switchover from day to night mode and vice-versa automatically.
- 6.5. All camera recordings shall have camera ID & location/area of recording as well as date/time stamp. Camera ID, location/area of recording date/time shall be programmable by the system administrator.
- 6.6. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.
- 6.7. Each camera shall have inbuilt memory feature for back-up configuration/time information when camera is powered off.

Technical Specification of Visual Monitoring System

- 6.8. The camera communication port shall be interfaced with media converter (Copper to Fiber) in the junction box. The media converter shall be connected through optical fiber cable to fiber port of LAN switch in control room. The junction box shall be preferred to be mounted on the same/near the structure/wall where camera has been installed.
- 6.9. Power Supply to camera shall be extended from the 230V AC from nearby distribution board in the switchyard/substation. Bidder shall be responsible for providing all installation accessories including industrial grade power converter, surge arrestor for extending supply to camera and its accessories to ensure trouble free operation. The power supply circuits feeding to VMS equipment as mentioned above shall be provided with MCB. Two MCB are to be provided per circuit (Camera) one at source end and one in camera junction box.
- 6.10. The camera should generally conform to Electromagnetic compatibility requirements for outdoor equipment in EHV switchyards.
The equipment should generally conform to Electromagnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:
- a) Electrical Fast Transient (Level 4) as per IEC 61000-4-4
 - b) Damped Oscillatory (1 MHz and 100 KHz) (level 3) as per IEC 61000-4-18
 - c) Electrostatic Discharge (Level 4) as per IEC 61000-4-2
 - d) Power Frequency Magnetic Field (level 4) as per IEC 61000-4-8
 - e) Ripple on DC Power Supply (level 4) as per IEC 61000-4-17
- Type test reports to establish compliance with the above requirement shall be submitted.
- 6.11. The Cameras shall have inbuilt Video Analytics. The alerts generated from analytics shall be visible in Client application.

IP Fixed Megapixel Camera Specifications

Sr. No.	Parameter	Requirement
1	Image Sensor	2-megapixel Progressive 1/3" or Better CMOS/CCD sensor, Minimum Illumination 0.5 LUX
2	Camera Enclosure Type	IP66 Grade
3	Iris/Focus	Auto/Manual
4	IR capability	50 meters with automatic switching from Daylight to IR mode.
5	Video Compression	User selectable Dual Stream H.265 and MPEG4
6	Video Definition	Primary stream: 1600x1200, 1280x960, 1280x720 or better. Secondary Stream: 800x600, 400x288, 192x144 or better
7	Video Parameters	Brightness, Hue, contrast, saturation and image quality.

Technical Specification of Visual Monitoring System

8	Video Frame Rate	PAL: 1-25 Frames/second or better
9	Video Output	One channel composite stream.
10	Supported protocols	TCP-IP, UDP, HTTP, FTP, SMTP, DHCP, DNS, ARP, ICMP, POP3, NTP, UpnP, RTP, RTCP
11	Operating Humidity	+5% of climatic condition of place
12	ONVIF	The camera should be ONVIF (Profile S, T, G & M) compliant
13	Analytics	The Cameras shall have inbuilt Video Analytics. The alerts generated from analytics shall be visible in Client application.

Outdoor Integrated IP PTZ Colour Camera Specifications

Sl. No.	Description	Minimum Specifications
1	Salient features	a) The cameras shall be IP and the Camera shall be compliant to ONVIF standards. ONVIF Profile (S, T, G & M)
		b) The cameras shall have PAN, TILT and ZOOM facilities.
		c) The cameras must be of Day and Night type.
		d) The cameras must be operative in automatic mode for switching from day mode to night mode depending on the ambient natural light intensity without having to manually operate.
		e) The Cameras shall be provided with built-in or external alarm input/ output ports minimum (1 in, 1 out)
		f) The VMS camera shall be suitable for wall mounting, ceiling mounting, pole mounting and switchyard structure mounting. All accessories required for the mounting shall be provided.
		g) It shall be possible to define at least 64 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location. It should be possible to name each of the preset position using at least 16 alphanumeric characters.
		h) Each Camera shall have an inbuilt memory for back-up configuration/ time information when camera is powered off.
		i) The cameras features must be quickly and easily accessible by provision of on-screen displays.
		j) The VMS camera shall have tamper proof feature i.e. it shall inform the Operator of any change in its placement, blocking of the view etc.

Technical Specification of Visual Monitoring System

		<p>k) The VMS camera shall store 'Tour' feature, i.e. perform a preconfigured PTZ movement and record the video during this movement. When the operator takes control of the camera, the camera shall move as per the operator's direction and return to the 'Tour' after a preconfigured amount of time. Minimum 2 tours or better per camera.</p> <p>l) The camera shall have Motion Detection feature.</p>
2	Other features	<ul style="list-style-type: none"> • Remote firmware updates • Secure backup of all camera settings • Password protection prevents unauthorized users from altering system settings • Built-in /external surge protection
3	Housing Enclosure	The cameras shall have IP—66 Protection Class enclosures. Enclosure shall have provision (heater, blower, etc.) to avoid fogging during high humidity condition & Camera shall be able to perform satisfactorily.
4	Camera Interface	The camera communication port shall be interfaced with a Media Converter (Copper to Fiber)/ Ethernet switch to be provided in a junction box. This Media Converter/ Ethernet switch shall be connected to fiber port of a network communication switch to be provided in control room through optical fiber cable. The junction box shall be mounted on the same/near the structure where camera has been installed.
5	Camera Mounting	Camera mounting/clamp size shall be robust enough to ensure no vibration which can affect the quality of video particularly at highest zoom level.
SPECIFICATIONS & FEATURES		
Camera/Optics:		
1.	Image sensor	1/2.8" Progressive scan CMOS
2.	Effective Pixel	(PAL): 1920 X 1080
3.	Lens	f (Focal length) = 4.3mm 129 mm or better, F Number range between F1 .6 -4.7, Horizontal Angle of View: 63 degree-2.3 degree or better
4.	Zoom	30x Optical zoom or better and 12 x digital zoom or better
5.	Electronic Shutter	1 ~ 1/10,000 sec. or better
6.	Iris Control	Automatic with manual override

Technical Specification of Visual Monitoring System

7.	SIN (signal to noise Ratio	≥ 50 dB
8.	Light Sensitivity lux	Color: 0.2 Lux at 30 IRE or better B&W: 0.01 Lux at 30 IRE or better
9.	Wide Dynamic Range	120 dB or better
10.	Scanning System	Progressive
11.	Electronic Image Stabilization	Integrated
12.	Image Enhancement	Integrated
Camera\Video:		
13.	Video Streams	Dual Stream: Primary stream: H.265 Secondary stream: H.265
14.	Available Resolution	Mainstream: 1920x1080/0.3-0.4MPx Sub Stream: 0.1-0.2MPx
15.	Frame rate	FPS should be selectable three setting between 1 -10 FPS and at least two setting between 10-25FPS, so that we can be able to do local recording in NVR with 0.3-0.4MPx resolution with abovementioned selectable FPS for primary stream. For Viewing if primary stream is not available then secondary stream at 1 FPS or better with 0.1-0.2MPx resolution is to be available.
16.	Supported Protocols:	TCP, IP (IPv4 / IPv6 compliant), NTP, UDP, Multicast (IGMP)
17.	Security	Multiple user access with password protection
18.	Panning Range	Complete 360 degrees endless
19.	Pan Speed	Variable 0.1° /sec ~ 120° /sec
20.	Tilting Range	Minimum 180° Tilt Rotation (+/- 90°)
21.	Preset Accuracy	+/- 0.1° or better
22.	PTZ Tracking	The camera should automatically pan, tilt & zoom to follow the moving object until the object stops or disappears from the monitored area
Camera\Dome drive features:		
23.	Video Motion Detection	To detect occurrence of motion in FOV of camera

Technical Specification of Visual Monitoring System

General		
24.	Working temperature	-5 ⁰ C to 50 ⁰ C (Test Certificate)
25.	Working Humidity	10 to 90 % (Test Certificate)
26.	Mounting	Camera shall be mounting/clamp size shall be robust enough to ensure no vibration which can affect the quality of video particularly at highest zoom level.
27	Analytics	The Cameras shall have inbuilt Video Analytics. The alerts generated from analytics shall be visible in Client application.

2. Client Machine

Client Machine shall be installed in the Control Room, Substation-in-charge as well as in the security In-charge room. User Interface for VMS software shall be provided on client machines and shall have all the features as per authority assigned by the administrator. The minimum specification for the client machine is as follows: -

Sr. No.	Item	Minimum Characteristics
1	General Features	
a	Processor	1x8 core, 3.2GHz
b	Operating System	Windows 11 Pro or latest compatible with VMS application
c	CPU/Clock Speed	3.2GHz or better
d	RAM	32GB-DDR4 or better (expandable up to 64GB)
e	DIMM Slots	2
f	Hard Disk	Min. 512GB SSD (expandable up to 1TB) and 1TB SATA HDD
g	Storage Drive	DVD +/- RW
h	Support for both IPv4 and	Yes (Static IP)
2	Interface	
a	I/O ports	1 x serial port, 1 x parallel port
b	USB ports	USB2.0/USB3.0 supported (Total 4 ports)
C	Ethernet Ports	2 x 10/100/1000 Mbps Ethernet ports
3	Graphics Card Support	4GB or better
4	User Interface	
a	Monitor	32" IPS widescreen LCD antiglare with WLED backlit colour monitor, resolution of 3840x2160 pixel

Technical Specification of Visual Monitoring System

Sr. No.	Item	Minimum Characteristics
b	Keyboard	Yes
c	Mouse	Yes
d	Speakers with Audible Alarms	USB powered external speakers
5	Power Supply	
a	Input	230 V (+/-10%) AC, 50 Hz
6	Anti-Virus Support	Yes (licensed), which can be patched offline

8. Power Supply (UPS) for NVR , Storage and Client Machines

UPS having minimum specification as detailed below shall be provided for NVR server, Storage and Client Machines located at the central location of Security VMS system.

Sr. No.	Parameter	Requirement
1	Rating	5KVA
2	Type	Online Microprocessor controlled IGBT based High Frequency.
3	Input	230V AC +/-10%
4	Output	230V AC +/-1%
5	Frequency	50Hz +/- 0.3%
6	Battery	Maintenance Free for 30 Min Backup.
7	Total Harmonic Dist.	Less than 2.5% for linear load.
8	Display metering	Input AC Voltage, UPS output voltage, UPS output current, UPS output frequency.
9	Display Indication	AC Mains “ON”, UPS “ON”, Overloaded.
10	Alarms (Visual and potential free contact)	DC Under Voltage (Low Battery), UPS overload/Common trouble alarm.

9. Storage

Storage having minimum specification as below shall be provided for archiving of 180 days data for “Important/Sensitive” location cameras and 15 days data from balance cameras (at 4CIF resolution @15FPS)

Sr. No	Item: NAS (Network Attached Storage)	Characteristics
1	Features	
a	User Interface	Status and activity provided via management interface. Status Indicators on front of Controller
b	RAID Level	RAID 6 or better
c	Cache Memory	1GB Read/Write or more
d	Upgradable firmware	Yes

Technical Specification of Visual Monitoring System

Sr. No	Item: NAS (Network Attached Storage)	Characteristics
e	Network Connectivity and Protocol Support	Ethernet Support or 2Gbps or better SAS support
f	Processor Speed	1.4 GHz or better
g	Operating System	Windows server 2025 or Redhat Linux 9.5 or better or latest tested version. In case, the End of Life/End of Support declared for offered Operating System, the Contractor has to Upgrade to latest version prior to SAT of System.
2	Interface	2 x 10/100/1000 Mbps Ethernet ports
a	Host port	2Gbps or better SAS ports per controller
b	Management Ethernet Port	Yes
3	No. of Controllers	2
4	Networking	
a	Support for	IP, DHCP and Static IP, Dynamic DNS, Jumbo Frames
b	External Ports:	Minimum 2 Ethernet ports of 10/100/1000 Mbps Base- TX
5	HDD	Hot pluggable HDD trays
a	Support for Storage	Minimum 4TB per bay
b	Minimum Drive Bays	4 Nos
6	Power Supply	
a	Input Requirements	230V (+/-10%) AC
7	Operating Temperature	+5°C of Maximum & -5°C of Minimum of climatic condition of place
8	Backup Capability	Support for full backup of storage with third party tools

10. Substation Ethernet Switches:

10.1. Ethernet Switches:

The Ethernet switch shall be required for networking of NVR server and cameras as per conceptual communication architecture suitable for operational requirements in substation environment. The ethernet switch should be a manageable switch. It shall operate with rated 230V AC ($\pm 10\%$) power supply (other than Substations) and 220V DC/110V DC ($+10\%/-15\%$) (in case of Substation premises). The switches shall be rack mountable in the panel with 19" rack size.. The Ethernet switches shall be compliant to IEC 61850-3.

10.2. Number of ports:

Each switch shall be provided with minimum three types of ports as below:

Technical Specification of Visual Monitoring System

- A. Giga Byte (Gig) copper Ethernet port: For connecting storage NVR server & client in redundant mode on different switches.
- B. Fast Ethernet (FE) copper port: For connecting NVR server & client in redundant mode on different switches.
- C. Optical Port (FO): For connecting camera and shall be compatible with communication with media converter installed in Camera JB.

Each switch shall have sufficient number of Gig port, FE port and FO ports. Switches shall be supplied to accommodate all cameras. Cameras are desired to be divided equally among switches to extent possible. The architecture shall be got approved by Engineer-In-charge during detailed engineering.

10.3. Functional Requirements & Features:

- (a) LED indication for port status. supply etc.
- (b) Support single mode fiber with 1310 nm wavelength

11. Fiber Optic Cable

The Bidder shall supply & install the optical fiber approach cable as required based on detailed site survey to be carried out by the Bidder during the project execution and the indicative architecture attached. Fiber Optic Cable shall consist of G.652D DWSM Fibers suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

11.1. Optical Electrical and Mechanical Requirements: The cable core shall comprise of tensile strength member(s), fiber support/bedding structure, core wrap/bedding, and an overall impervious jacket. The Fiber Optic cable is of Single Mode communicating at 1310nm. Fiber Cables shall have minimum 4Core as indicated in the Architecture.

11.2. Installation of Fiber Cable: The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Bidder shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, same shall be laid buried at a depth of 300 mm in HDPE pipes. All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of Fiber Optic cables shall be supplied and installed by the Bidder.

11.3. Optical Fiber Termination and Splicing: Optical fiber terminations be done in LIUs/ as indicated in the Architecture. FODP/LIU shall be designed to provide protection for fiber splicing of pre-connectorized pigtails and to accommodate connector termination and coupling of the fiber cables. All the cores of Fiber cable are to be terminated in the LIU at switchyard end.

12. Power Cable

The power cable shall be 3C x 2.5 sq.mm size with stranded copper conductor. The power cable laid in the outdoor switchyard area shall be PVC insulated 1100V grade, armoured, FR type, C1 category confirming to IS:1554 (Part-I) and its amendments.

13. Media converter

Media converter (dual Port) shall be installed preferably in camera JB with suitable mounting arrangement; it will provide interface between camera's Ethernet cables in camera JB to switch installed in control room connected through OFC. It shall have LED indicators showing healthiness of link, power status, etc. It must have suitable Ethernet interface 10/100 Mbps, support IEEE 802.3 10Base-T, 802.3u 100Base-TX and 100Base-FX standards, IEEE 802.3x Flow Control & Back Pressure. The media converter shall have dual port for ring formation, if required, which shall be finalized during detail engineering.

Media converter shall be communicating with substation switch through single mode optical fiber cable on 1310nm wavelength.

It should be of industrial grade type with operating temperature range +5⁰ C of Maximum & -5⁰ C of Minimum of climatic condition of place and humidity +5% of climatic condition of place.

13.1. Cat6 STP cable

Suitable Cat6 STP communication cable for connecting camera with converter installed in camera junction Box.

13.2. Ethernet LAN cable

Suitable cat6 Ethernet LAN cable for connecting NVR server, Storage and Client machine with LAN switch

14. HDPE pipe

It shall be used for laying power cable, optical fiber cable in buried portion at the depth of 300 mm. It shall also be used for laying Ethernet and power cable from Camera JB to Camera on pole/tower. HDPE pipe installed on pole and tower shall be properly clamped. The HDPE pipe shall have minimum "Mean Outside Diameter of 25.00mm or higher". The PE grade of HDPE pipe shall be "PE-80 or higher".

15. Junction Box (JB)

The junction box shall accommodate all the necessary equipments except the camera required at the camera end and shall be mounted on/near the same lattice structure / poles as the camera. All the installation accessories like power converter / LIU / Media converter / Fiber patch cords etc shall be mounted inside the junction box and shall be of industrial grade type suitable for permanent outdoor use in Extra high voltage substation environment upto 765kV for ambient temperature of 0 deg C to +55 deg C and humidity of 10% to 90%. The junction box shall have the following features:

- It should have enough space to accommodate all the equipment.
- It shall have provision for mounting on the lattice structure or supplied pole.
- It shall be made of aluminium of thickness 3mm and shall be weather proof meeting IP 66 rating.

Technical Specification of Visual Monitoring System

- It should have suitable terminating blocks/ connections for terminating all types of cables utilized viz. power, Ethernet, fiber etc.
- Size of Junction box 545x545x250 mm minimum.

The Power converter for providing supply to Camera and the media converter shall be 230V AC ($\pm 10\%$) power supply (other than Substations) and 220V DC/110V DC ($+10\%/-15\%$) (in case of Substation premises) as per manufacturer's recommendation. Adequate backup power must be ensured for the cameras in the event of an AC power supply failure, to prevent any disruption to the camera feed.

The junction box shall be earthed to nearest earthing point through 25 X 6 mm GI flat/Braided strips.

16. FODP

FODP (Fiber optic distribution panel) shall be supplied and installed at locations to connect multiple optical fiber cable.

17. Power converter

Suitable industrial grade power converter shall be supplied for converting 230V AC ($\pm 10\%$) power supply (other than Substations) and 220V DC/110V DC ($+10\%/-15\%$) (in case of Substation premises) to rated power supply for camera. Power converter shall be in Junction box. The Contractor shall provide 2 Nos MCB with suitable rating shall be used for each camera. One shall be installed inside Camera JB and other at Source end.

18. MCB

02 Nos MCB with suitable rating shall be used for each camera. One shall be installed inside Camera JB and other at Source end.

19. LIU

LIU shall be supplied with accessories (Suitable Connectors, pig tail, patch cord, etc). LIU shall be used in camera JB and control room. LIU shall be suitable for installation in camera JB and rack at control room. LIU in control room shall have provision to accommodate multiple FO cables.

20. Pole

Bidder shall explore the possibility of installing camera on existing structure (Lighting pole, building structure, etc.), however if suitable structure is not available then pole of suitable height 6m/9m/12m may be chosen depending upon the location. Number of pole requirement shall be earmarked in survey report. Three types of typical pole drawing (6M/9M/12M) attached as reference.

Bidder shall finalize the poles depending upon the location (Along boundary wall, main gate, store, etc.) of cameras with necessary modification (if any) for installation of camera and Junction box during engineering stage. Approval of modified drawing may be taken by concerned department.

Technical Specification of Visual Monitoring System

Earthing of the poles should be connected to the switchyard main earth mat wherever it is available, else, the same should be earthed through 3mtr long, 20 mm dia, earth electrode.

21. HDPE Pipe

Suitable HDPE pipe shall be used for laying power cable, OFC cable at road crossing, culvert and in buried portions.

22. Networking Rack

Bidder in coordination with site personnel shall explore the possibility of installing Ethernet LAN switches and LIUs of control room in existing Rack/Panel available at substation. In case of non-availability of space in existing rack/panel, a networking rack shall be provided on approval of site in-charge of POWERGRID to accommodate Ethernet switches and LIUs as per BOQ and specification enclosed. Also place for installation of networking rack shall be earmarked in survey report.

23. Spares

One sets of supplied cameras along with accessories at each substation, detail BOQ of spare is attached.

Availability of Spares

The Bidder shall ensure the availability of spare parts and service support for all items supplied by the Bidder for a period of 07 years from the issuance of TOC (Taking over certificate).

24. Maintenance of System: The VMS system consisting of all the hardware and software to be supplied and commissioned under this package shall be one year warranty i.e. Defect Liability Period (DLP) commencing from the issuance of TOC and six year maintenance period thereafter. The maintenance of the system is to be carried out as per scope of maintenance (AMC).

SCOPE OF MAINTENANCE (AMC):

Introduction:

A comprehensive on-site maintenance shall be offered by the Bidder. The scope shall include all the software and hardware including cameras & accessories supplied by the Bidder for the VMS systems under this project. It shall include repair and replacement of supplied hardware and software to make system operational as per specification.

The essence of the maintenance services is to provide maintenance support for the supplied software and hardware including cameras & accessories, with the goal of meeting the availability as set forth herein.

The period of AMC is six years which commence after Defect Liability Period (DLP).

Comprehensive maintenance shall have two parts, viz:

- I. Preventive Maintenance of VMS
- II. Breakdown Maintenance of VMS

Scope of Bidder:

Technical Specification of Visual Monitoring System

- a) On receipt of complaint from the POWERGRID, Corrective / breakdown maintenance shall be attended immediately by the Bidder as per Response Time & Up-Time specified below.
- b) Bidder should maintain sufficient spares without any financial implication to POWERGRID for immediate restoration of the system under breakdown.
- c) A service report has to be submitted by the Bidder to POWERGRID after rectifying the fault. A record will be maintained of all such breakdowns attended by the Bidder.
- d) The faulty device/part shall be issued to Contactor by POWERGRID for further repair and return to POWERGRID site.
- e) The equipment being taken to the Service Centre for repair and its transportation would be at risk and cost of Bidder. Any damage or loss caused to the equipment shall be in the scope of Bidder.
- f) All consumable, spare required for complete AMC work including tools and testing instruments shall be arranged by the Bidder.
- g) Bidder will take all due necessary safety precautions for proper safety of man & machine while carrying out the work at site. Bidder will also be required to take necessary employee (workmen) compensation insurance cover for the personnel deputed for the work covered under this contract. POWERGRID shall have no responsibility whatsoever for claims arising out of accident or any other reason for the personnel deployed by the Bidder.
- h) After completion of the rectification, the Bidder shall submit the root cause of defect and corrective actions done to the Engineer-in-Charge.

Scope of POWERGRID

- a) POWERGRID shall nominate sole coordinator and act as interface between POWERGRID and the Bidder.
- b) POWERGRID shall arrange entry passes/ PTW/Gate pass etc. required for maintenance work entry and exit records at site.
- c) Outage of system due to fiber/power cable cut during bay extension, excavation work etc.; carried out by POWERGRID shall not be considered for penalty

24.1. Preventive Maintenance of VMS:

The Bidder shall carry out the preventive maintenance of the VMS system at site to keep the system running at its optimum level by checking its performance through diagnosis and doing necessary tuning / adjustment including rectification of all software and hardware including cameras & accessories failures and any abnormality observed. The bidder shall carryout quarterly preventive maintenance visits. Purpose of visit is to check proper working of system. Bidder to follow preventive maintenance schedule as per OEM's recommendations.

24.1.1. Following activities shall be carried out during the site visit, but not limited to:

- Check the camera, monitor, server & operator station functioning and overall healthiness of the system
- Cleaning of the camera internals, housing glass

Technical Specification of Visual Monitoring System

- Checking of lens operation,
- Checking of components of all CCTV equipment such as enclosure, JBs, Convertors etc
- Check the signal level for clear image quality.
- Servicing and greasing of the camera moving parts, if any.
- Check recording and playback functions.
- Report and attend any problem if found during the checking of the system.
- Prepare and submit the service report in tabular format for each & every component in the CCTV system after every visit to the Engineer-in-charge. In case of any breakdown of Camera or any other equipment, vendor to carry out root-cause analysis & proper precautions to be taken to avoid it happening again.
- Service record sheets, schedule & check list are to be maintained. It is to be signed by vendor's service engineer & POWERGRID site engineer after every service/check.

24.2. Breakdown Maintenance of VMS:

Fault Reporting:

Immediately on noticing the fault, the fault Will be reported by POWERGRID on phone/e-mail to the Bidder and the details will be informed as per enclosed format. The fault reporting time through email shall be taken as reference time for the purpose of calculation of Response time (RT) and up time (UT). The response time and uptime are defined below:

Response Time (RT) – The time taken by the Bidder to reach the site. It will be maximum 48 Hrs excluding Sundays and National Holidays.

Uptime (UT) -The time taken for resolution of the fault. It shall be maximum 48 hours after access to the site.

24.3. Terms of Payment During AMC:

24.3.1. Annual Maintenance (AMC) Charges:

AMC charges shall be paid as per provision in bidding document on submission of invoice by Bidder and on certification by the Employer in line with provision of technical specifications.

24.3.2. Deduction during AMC:

Bidder shall maintain the VMS system as per above defined RT and UT. However, if the RT+UT is greater than 96 Hrs, then (₹...../- to be entered by region/site) per fault/event shall be deducted from the running bill of AMC.

24.4. Taking Over Certificate: Taking over certificate (TOC) shall be issued by Engineer-in-charge after successful commissioning.

Technical Specification of Visual Monitoring System

The successful commissioning procedure shall be submitted by Bidder for approval from POWERGRID within 60 days of award of contract.

Anything not mentioned above or in BOQ but required to complete the Job and to make the system functional shall be arranged and supplied by the Bidder adhering to the quality norms as per Technical specification.

The Bidder shall submit a site survey report along with detailed execution plan and layout drawing to Engineer In-charge for approval.

The work shall be executed as per approved site execution plan and layout/Drawing.

25. Cyber Security Requirements

The bidder has to adhere the guidelines/recommendations related to CCTV system issued by various statutory authorities like CEA, Cert-In, NCIIPC, MeitY, etc. The bidder must comply the “**Advisory on the Threat of Information Leakage through CCTV/ Video Surveillance system (VSS)/ Digital Video Recorders /Network Video Recorders**” and its amendments issued by MeitY from time to time. The contractor shall submit the declaration for the compliance of above circular during the detailed engineering stage. The employer shall verify the features during SAT stage. The minimum requirements are summarized as follows:

- a. **CCTV Device testing and certification:** The contractor shall ensure compliance of CCTV Cameras (Analog/ IP/ Analog Speed Dome/ IP Speed Dome) with the Essential Requirements (ERs) notified as part of the PPO for CCTV in Gazette of India (EXTRAORDINARY, PART II—Section 3—Sub-section (ii) dated 7th March, 2024, at Sr. No. No. 1062) to ensure the security of the VSS / CCTV systems, as amended from time to time. The security testing certificate for CCTV/VSS to be issued by Standardisation Testing and Quality Certification (STQC) Laboratory or any other agency notified by MeitY from time to time. The validity of the test report issued by STQC Lab will be three years from the date of issue of the report.

The contractor shall submit the self-signed declaration in case of non-availability of testing facility. The contractor shall carry out required testing for the offered equipment as and when testing facilities are available during entire period of contract.

- b. **Strong Passwords, disable unused features:**

Following to be ensured by the contractor at the time commissioning of CCTV system:

- All default passwords for accessing CCTV and associated equipment such as NVR, client machine, etc. to be changed and updated with strong and unique passwords.
- Unnecessary features which are not required for proper functioning of the CCTV system to be turned off or disabled.
- Unused user accounts (e.g., Guest User), management/media ports, services/daemons on the device to be disabled.
- Change or disable settings that are insecure by default (e.g., default password, SNMP “public” community string).

Technical Specification of Visual Monitoring System

- c. **Regular Firmware Updates:** It shall be the responsibility of the contractor to regularly check for updates including security updates provided by OEM for the supplied CCTV cameras and associated equipment and apply them promptly in offline manner.

26. Support during Vulnerability Assessment and Penetration Testing

POWERGRID conducts VA/PT of CCTV system through third party auditor on regular basis. The vendor shall provide support for mitigation of identified security loopholes during the VA/PT.

Technical Specification of Visual Monitoring System

Indicative BOQ of VMS system			
Sr. No	Item Description	Unit	Qty.
Supply and Installation as per Technical Specification			
1	Fixed Camera	Set	Shall be finalized during detailed engineering.
2	Outdoor Integrated IP PTZ Color Camera	Set	
3	Junction box	Nos.	
4	Power converter	Nos.	
5	MCB	Nos.	
6	Media converter	Nos.	
7	Light interfacing unit at Camera end	Nos.	
8	Light interfacing unit at control room end	Nos.	
9	Network video recorder with TFT 22" High resolution monitor and NVR application software	set	
10	Ethernet LAN Switch	Nos.	
11	19-inch Networking Rack	Nos.	
12	Optical fiber Cable	meter	
13	Power cable	meter	
14	Cat6 STP cable	meter	
15	Ethernet LAN cable	meter	
16	HDPE Pipe	meter	
17	FODP	Nos.	
18	NAS	set	
19	Pole	Nos.	
20	Client Machine	set	
21	UPS (as per technical specification)	set	

Technical Specification of Visual Monitoring System

Section

SWITCHGEAR (for BESS)

Contents

1. GENERAL 2

2. SWITCHGEAR - CIRCUIT BREAKER (CB) 2

3. SWITCHGEAR-INSTRUMENT TRANSFORMERS 2

4. SWITCHGEAR – ISOLATOR 3

5. SWITCHGEAR - SURGE ARRESTER 4

SWITCHGEAR

(for Battery Energy Storage System)

1. GENERAL

The Circuit Breakers, Instrument Transformers, Isolators & Earth Switch, Surge Arresters shall be designed for use in the geographic and meteorological conditions as given in Section-Project.

2. SWITCHGEAR - CIRCUIT BREAKER (CB)

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards and shall also be in accordance with requirements specified in Section-GTR. The circuit breaker shall be complete with operating mechanism, common marshalling box, piping, inter-pole cables, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure, platform with ladder for CB, foundation bolts and all other accessories required for carrying out all the functions of the CB (as applicable based on voltage level & manufacturer design). All necessary parts to provide a complete and operable circuit breaker installation such as terminal pads, control parts and other devices shall be provided. Painting shall be done in line with Section – GTR. The support structure, platform & ladder of circuit breaker shall be hot dip galvanised. Exposed hardware items shall be hot dip galvanised or Electro-galvanised.

For Circuit Breakers, voltage level, nominal current rating, short circuit withstand capability etc. shall be finalized during detailed engineering. All porcelain & polymer hollow column insulators (as applicable) shall conform to IEC-62155 & IEC-61462 respectively. In accordance with the requirements stipulated under Section-GTR the circuit breaker along with its operating mechanism shall conform to the type tests & routine tests requirement as per IEC: 62271-100 & test reports shall be submitted for the Employer's review.

3. SWITCHGEAR-INSTRUMENT TRANSFORMERS

The instrument transformers and accessories shall conform to the latest version of the standards specified below and shall be in accordance with the requirements in Section-GTR.

- i. Current Transformers (CT): IEC: 61869-1 & 61869-2 or IS: 2705 Part-1 to 4.
- ii. Capacitive Voltage Transformers (CVT): IEC: 61869-1, 61869-5 & IEC-60358 or IS-3156 Part-1 to 4.
- iii. Inductive Voltage Transformers (IVT): IEC: 61869-1 & 61869-3 or IS-3156 Part-1 to 3.

Instruments transformers shall be hermetically sealed units. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal

block. The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers. The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per Section-GTR. External surface of aluminium can have natural finish. For all instrument transformers, voltage level, nominal current rating, short circuit withstand capability, Secondary side number of cores, ratio, burden, accuracy class etc. shall be finalized during detailed engineering. In accordance with the requirements in Section-GTR, Current Transformer and Voltage Transformer should have been type tested and shall be subjected to routine tests in accordance with relevant IEC. The test reports of type tests, as applicable, as per IEC-61869-2 for CT, IEC-61869-5/IEC-60358 for CVT, and IEC-61869-3 for IVT shall be submitted for the Employer's review.

4. SWITCHGEAR – ISOLATOR

The Isolators and accessories shall conform in general to IS/ IEC: 62271-102 latest edition and shall be in accordance with requirement of Section-GTR. Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following:

- i. Isolator with complete Support Insulators, operating rod insulator, base frame, linkages, operating mechanism, control cabinet, interlock etc.
- ii. All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the rated short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks. The interlocking coil shall be suitable for continuous operation from station DC supply and within a variation range as stipulated in Section-GTR. The earthing switches shall be capable of discharging trapped charges of the associated lines/ sections. For Isolators, voltage level, nominal current rating, short circuit withstand capability etc. shall be finalized during detailed engineering.

The insulator shall conform to IS: 2544, IEC-60168 and IEC-60815. The porcelain of the insulator shall conform to the requirements stipulated under Section-GTR. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be only locally operated. Each earth switch shall be provided with flexible copper/aluminium braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

In continuation to the requirements stipulated under Section-GTR the isolator along with its earthing switch and operating mechanism should be type tested as per IEC/IS and shall be

subjected to routine tests in accordance with latest edition of IEC-62271-102. The test reports of the type tests as per latest IS/IEC 62271-102 shall also be submitted for the Employer's review.

5. SWITCHGEAR - SURGE ARRESTER

The Surge arresters shall conform to IS 15086 part 4/IEC: 60099-4 (latest edition) shall also be in accordance with requirements under Section -GTR.

The surge arresters shall be of Station High Duty (SH) / Station Medium Duty (SM) / Station Low Duty (SL) as per requirement and gapless type without any series or shunt gaps.

The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations. Arresters shall be of hermetically sealed units, self-supporting construction. For Surge Arresters, rated voltage, continuous operating voltage, nominal discharge current, maximum residual voltage at nominal discharge current etc. shall be finalized during detailed engineering.

Arresters shall be complete with insulating base having provision for bolting to flat surface of structure. Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection arrangement. Suitable leakage current meters should also be provided. Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection (for outdoor applications).

All routine tests shall be conducted on the hollow column insulators as per IEC 62155. Polymer housing shall be tested in accordance to IEC-61462. In accordance with the requirements stipulated under Section-GTR, the surge arresters should have been type tested as per latest IEC/IS and shall be subjected to routine and acceptance tests in accordance with latest IEC/IS. Test reports for all type tests as per latest IS 15086 part4/IEC-60099-4 shall also be submitted for the Employer's review.

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TABLE: ENVIRONMENTAL MANAGEMENT PLAN

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
Pre-construction							
Location of transmission towers and transmission line alignment and design	Exposure to safety related risks	Setback of dwellings to overhead line route designed in accordance with permitted level of power frequency and the regulation of supervision at sites.	Tower location and line alignment selection with respect to nearest dwellings	Setback distances to nearest houses - once	POWERGRID	Part of tower siting survey and detailed alignment survey and design	Transmission Line Tower Packages
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	PCBs not used in substation transformers or other project facilities or equipment.	Transformer design	Exclusion of PCBs in transformers stated in tender specification - once	POWERGRID	Part of tender specifications for the equipment	Substation Equipment /Packages*
		Processes, equipment and systems not to use chlorofluorocarbons (CFCs), including halon, and their use, if any, in existing processes and systems should be phased out and to be disposed of in a manner consistent with the requirements of the Government	Process, equipment and system design	Exclusion of CFCs stated in tender specification – once	POWERGRID	Part of tender specifications for the equipment	
				Phase out schedule to be prepared in case still in use – once		Part of equipment and process design	
Transmission line design	Exposure to electromagnetic	Transmission line design to comply with	Electromagnetic field strength for	Line design compliance	POWERGRID	Part of detailed alignment	Transmission Line Tower

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
	interference	the limits of electromagnetic interference from overhead power lines	proposed line design	with relevant standards - once		survey and design	Packages
Location of transmission towers and transmission line alignment and design	Impact on water bodies and land	Consideration of tower location at where they could be located to avoid water bodies or agricultural land.	Tower location and line alignment selection (distance to water and/or agricultural land)	Consultation with local authorities and land owners - once	POWERGRID	Part of tower siting survey and detailed alignment survey and design	Transmission Line Tower Packages
	Social inequities	Careful route selection to avoid existing settlements	Tower location and line alignment selection (distance to nearest dwellings or social institutions)	Consultation with local authorities and land owners - once	POWERGRID	Part of detailed tower siting and alignment survey and design	
		Minimise need to acquire agricultural land	Tower location and line alignment selection (distance to agricultural land)	Consultation with local authorities and land owners - once	POWERGRID	Part of detailed tower siting and alignment survey and design	
Encroachment into precious ecological areas	Loss of precious ecological values/ damage to precious species	Avoid encroachment by careful site and alignment selection	Tower location and line alignment selection (distance to nearest designated ecological protection area)	Consultation with local authorities - once	POWERGRID	Part of detailed siting and alignment survey /design	Transmission Line Tower Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
		Minimise the need by using existing towers and RoW wherever possible	Tower location and line alignment selection	Consultation with local authorities and design engineers - once	POWERGRID	Part of detailed siting and alignment survey/design	
Transmission line through forestland	Deforestation and loss of biodiversity	Avoid encroachment by careful site and alignment selection	Tower location and line alignment selection (distance to nearest protected or reserved forest)	Consultation with local authorities - once	POWERGRID	Part of detailed siting and alignment survey/design	Transmission Line Tower Packages
		Minimise the need by using existing towers, tall towers and RoW, wherever possible		Consultation with local authorities and design engineers - once			
		Obtain statutory clearances from the Government	Statutory approvals from Government	Compliance with regulations – once for each subproject			
Encroachment into farmland	Loss of agricultural productivity	Use existing tower footings/towers wherever possible	Tower location and line alignment selection	Consultation with local authorities and design engineers - once	POWERGRID	Part of detailed alignment survey and design	Transmission Line Tower Packages
		Avoid siting new towers on farmland wherever feasible	Tower location and line alignment selection	Consultation with local authorities and design engineers - once		Part of detailed siting and alignment survey /design	

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
		Farmers compensated for any permanent loss of productive land	Design of Implementation of Crop Compensation (based on affected area)	Consultation with affected parties – once in a quarter		Prior to construction phase	
		Farmers/landowners compensated for significant trees that need to be trimmed/ removed along RoW.	Design of Implementation of Tree compensation (estimated area to be trimmed/removed)	Consultation with affected parties – once in a quarter		Prior to construction phase	
			Statutory approvals for tree trimming /removal	Compliance with regulations – once for each subproject		Part of detailed siting and alignment survey /design	
Noise related	Nuisance to neighbouring properties	Substations sited and designed to ensure noise will not be a nuisance.	Noise levels	Noise levels to be specified in tender documents - once	POWERGRID	Part of detailed equipment design	Substation Packages
Interference with drainage patterns/Irrigation channels	Flooding hazards/loss of agricultural production	Appropriate siting of towers to avoid channel interference	Tower location and line alignment selection (distance to nearest flood zone)	Consultation with local authorities and design engineers - once	POWERGRID	Part of detailed alignment survey and design	Transmission Line Tower Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
Escape of polluting materials	Environmental pollution	Transformers designed with oil spill containment systems, and purpose-built oil, lubricant and fuel storage system, complete with spill cleanup equipment.	Equipment specifications with respect to potential pollutants	Tender document to mention specifications - once	POWERGRID	Part of detailed equipment design /drawings	Transformer specifications
		Substations to include drainage and sewage disposal systems to avoid offsite land and water pollution.	Substation sewage design	Tender document to mention detailed specifications - once	POWERGRID	Part of detailed substation layout and design /drawings	Substation packages (civil)
Equipment submerged under flood	Contamination of receptors (land, water)	Substations constructed above the high flood level (HFL) by raising the foundation pad.	Substation design to account for HFL (elevation with respect to HFL elevation)	Base height as per flood design - once	POWERGRID	Part of detailed substation layout and design /drawings	Substation packages (civil)
Explosions/Fire	Hazards to life	Design of substations to include modern fire control systems/firewalls.	Substation design compliance with fire prevention and control codes	Tender document to mention detailed specifications - once	POWERGRID	Part of detailed substation layout and design /drawings	Substation packages
		Provision of fire fighting equipment to be located close to transformers.					
Construction							
Equipment layout and installation	Noise and vibrations	Construction techniques and machinery selection seeking to minimize ground disturbance.	Construction techniques and machinery	Construction techniques and machinery creating minimal ground disturbance -	POWERGRID (Contractor through contract provisions)	Construction period	All packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
				once at the start of each construction phase			
Physical construction	Disturbed farming activity	Construction activities on cropping land timed to avoid disturbance of field crops (within one month of harvest wherever possible).	Timing of start of construction	Crop disturbance – Post harvest as soon as possible but before next crop - once per site	POWERGRID (Contractor through contract provisions)	Construction period	All packages
Mechanized construction	Noise, vibration and operator safety, efficient operation	Construction equipment to be well maintained.	Construction equipment – estimated noise emissions	Complaints received by local authorities - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All packages
	Noise, vibration, equipment wear and tear	Turning off plant not in use.	Construction equipment – estimated noise emissions and operating schedules	Complaints received by local authorities - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	
Construction of roads for accessibility	Increase in airborne dust particles	Existing roads and tracks used for construction and maintenance access to the line wherever possible.	Access roads, routes (length and width of new access roads to be constructed)	Use of established roads wherever possible - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	Transmission Line Tower Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
	Increased land requirement for temporary accessibility	New access ways restricted to a single carriageway width within the RoW.	Access width (meters)	Access restricted to single carriageway width within RoW - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	
Temporary blockage of utilities	Overflows, reduced discharge	Temporary placement of fill in drains/canals not permitted.	Temporary fill placement (m ³)	Absence of fill in sensitive drainage areas - every 4 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Site clearance	Vegetation	Marking of vegetation to be removed prior to clearance, and strict control on clearing activities to ensure minimal clearance.	Vegetation marking and clearance control (area in m ²)	Clearance strictly limited to target vegetation - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Trimming/cutting of trees within RoW	Fire hazards	Trees allowed growing up to a height within the RoW by maintaining adequate clearance between the top of tree and the conductor as per the regulations.	Species-specific tree retention as approved by statutory authorities (average and maximum tree height at maturity, in meters)	Presence of target species in RoW following vegetation clearance – once per site	POWERGRID (Contractor through contract provisions)	Construction period	Transmission Line Tower Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
	Loss of vegetation and deforestation	Trees that can survive pruning to comply should be pruned instead of cleared.	Species-specific tree retention as approved by statutory authorities	Presence of target species in RoW following vegetation clearance – once per site	POWERGRID (Contractor through contract provisions)	Construction period	Transmission Line Tower Packages
		Felled trees and other cleared or pruned vegetation to be disposed of as authorized by the statutory bodies.	Disposal of cleared vegetation as approved by the statutory authorities (area cleared in m ²)	Use or intended use of vegetation as approved by the statutory authorities – once per site	POWERGRID (Contractor through contract provisions)	Construction period	
Wood/vegetation harvesting	Loss of vegetation and deforestation	Construction workers prohibited from harvesting wood in the project area during their employment, (apart from locally employed staff continuing current legal activities).	Illegal wood /vegetation harvesting (area in m ² , number of incidents reported)	Complaints by local people or other evidence of illegal harvesting - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Surplus earthwork/soil	Runoff to cause water pollution, solid waste disposal	Soil excavated from tower footings disposed of by placement along roadsides, or at nearby house blocks if requested by landowners.	Soil disposal locations and volume (m ³)	Acceptable soil disposal sites - every 2 weeks	POWER GRID (Contractor through contract provisions)	Construction period	Transmission Line Tower Packages
Substation construction	Loss of soil	Fill for the substation foundations obtained by creating or improving	Borrow area siting (area of site in m ² and estimated	Acceptable borrow areas that provide a	POWERGRID (Contractor through	Construction period	Substation Package (Civil)

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
		local water supply ponds or drains, with the agreement of local communities.	volume in m ³)	benefit - every 2 weeks	contract provisions)		
Substation construction	Water pollution	Construction activities involving significant ground disturbance (i.e. substation land forming) not undertaken during the monsoon season.	Seasonal start and finish of major earthworks (pH, BOD/COD, Suspended solids, other ?)	Timing of major disturbance activities - prior to start of construction activities	POWERGRID (Contractor through contract provisions)	Construction period	Substation Package (Civil)
Site clearance	Vegetation	Tree clearances for easement establishment to only involve cutting trees off at ground level or pruning as appropriate, with tree stumps and roots left in place and ground cover left undisturbed.	Ground disturbance during vegetation clearance (area, m ²)	Amount of ground disturbance - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	Substation Package (Civil)
			Statutory approvals	Statutory approvals for tree clearances – once for each site	POWERGRID (Contractor through contract provisions)	Construction period	
Tower construction – disposal of surplus earthwork/fill	Waste disposal	Excess fill from tower foundation excavation disposed of next to roads or around houses, in agreement with the local community or landowner.	Location and amount (m ³) of fill disposal	Appropriate fill disposal locations - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	Transmission Line Tower Packages
Storage of chemicals and materials	Contamination of receptors (land, water, air)	Fuel and other hazardous materials securely stored above high flood level.	Location of hazardous material storage; spill reports (type of	Fuel storage in appropriate locations and receptacles -	POWERGRID (Contractor through contract	Construction period	All Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
			material spilled, amount (kg or m ³) and action taken to control and clean up spill)	every 2 weeks	provisions)		
Construction schedules	Noise nuisance to neighbouring properties	Construction activities only undertaken during the day and local communities informed of the construction schedule.	Timing of construction (noise emissions, [dB(a)])	Daytime construction only - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	Amenities for Workforce facilities	Presence of proper sanitation, water supply and waste disposal facilities - once each new facility	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Encroachment into farmland	Loss of agricultural productivity	Use existing access roads wherever possible	Usage of existing utilities	Complaints received by local people /authorities - every 2 weeks	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
		Ensure existing irrigation facilities are maintained in working condition	Status of existing facilities				
		Protect /preserve topsoil and reinstate after construction completed	Status of facilities (earthwork in m ³)				
		Repair /reinstate damaged bunds etc after construction completed	Status of facilities (earthwork in m ³)				

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
	Social inequities	Compensation for temporary loss in agricultural production	Implementation of Crop compensation (amount paid, dates, etc.)	Consultation with affected parties – once in a quarter	POWERGRID	Prior to construction	
Uncontrolled erosion/silt runoff	Soil loss, downstream siltation;	Need for access tracks minimised, use of existing roads.	Design basis and construction procedures (suspended solids in receiving waters; area re-vegetated in m ² ; amount of bunds constructed [length in meter, area in m ² , or volume in m ³])	Incorporating good design and construction management practices – once for each site	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
		Limit site clearing to work areas					
		Regeneration of vegetation to stabilise works areas on completion (where applicable)					
		Avoidance of excavation in wet season					
		Water courses protected from siltation through use of bunds and sediment ponds					
Nuisance to nearby properties	Losses to neighbouring land uses/ values	Contract clauses specifying careful construction practices.	Contract clauses	Incorporating good construction management practices – once for each site	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
		As much as possible existing access ways will be used.	Design basis and layout	Incorporating good design engineering practices – once for each site			

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
		Productive land will be reinstated following completion of construction	Reinstatement of land status (area affected, m ²)	Consultation with affected parties – twice – immediately after completion of construction and after the first harvest			
	Social inequities	Compensation will be paid for loss of production, if any.	Implementation of Tree/Crop compensation (amount paid)	Consultation with affected parties – once in a quarter	POWERGRID	Prior to construction	
Flooding hazards due to construction impediments of natural drainage	Flooding and loss of soils, contamination of receptors (land, water)	Avoid natural drainage pattern /facilities being disturbed /blocked /diverted by the on-going construction activities	Contract clauses (e.g., suspended solids and BOD/COD in receiving water)	Incorporating good construction management practices – once for each site	POWERGRID (Contractor through contract provisions)	Construction period	All packages
Equipment submerged under flood	Contamination of receptors (land, water)	Equipment stored at secure place above the high flood level (HFL).	Store room level to be above HFL (elevation difference in meters)	Store room level as per flood design - once	POWERGRID	Construction period	# All packages
Inadequate siting of borrow areas (quarry areas)	Loss of land values	Existing borrow sites will be used to source aggregates, therefore, no need to develop new sources of aggregates	Contract clauses	Incorporating good construction management practices – once for each	POWERGRID (Contractor through contract provisions)	Construction period	Substation Packages

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
Health and safety	Injury and sickness of workers and members of the public	Contract provisions specifying minimum requirements for construction camps Contractor to prepare and implement a health and safety plan. Contractor to arrange for health and safety training sessions	Contract clauses (number of incidents and total lost-work days caused by injuries and sickness)	Contract clauses compliance – once every quarter site	POWERGRID (Contractor through contract provisions)	Construction period	All Packages
Inadequate construction stage monitoring	Likely to maximise damages	Training of POWERGRID environmental monitoring personnel Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	Training schedules Respective contract checklists and remedial actions taken thereof. Compliance report related to environmental aspects for the contract	Number of programs attended by each person – once a year Submission of duly completed checklists of all contracts for each site - once Submission of duly completed compliance report for each contract - once	POWERGRID	Routinely throughout construction period	All Packages
Operation and Maintenance							
Location of transmission	Exposure to safety related	Setback of dwellings to overhead line route	Compliance with setback distances	Setback distances to	POWERGRID	During operations	Transmission Line Tower

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
towers and transmission line alignment and design	risks	designed in accordance with permitted level of power frequency and the regulation of supervision at sites.	(“as-built” diagrams)	nearest houses – once in quarter			Packages
Equipment submerged under flood	Contamination of receptors (land, water)	Equipment installed above the high flood level (HFL) by raising the foundation pad.	Substation design to account for HFL (“as-built” diagrams)	Base height as per flood design - once	POWERGRID	During operations	All packages
Oil spillage	Contamination of land/nearby water bodies	Substation transformers located within secure and impervious bunded areas with a storage capacity of at least 100% of the capacity of oil in transformers and associated reserve tanks.	Substation bunding (“as-built” diagrams)	Bunding capacity and permeability - once	POWERGRID	During operations	Substation Packages*
Inadequate provision of staff/workers health and safety during operations	Injury and sickness of staff /workers	Careful design using appropriate technologies to minimise hazards	Usage of appropriate technologies (lost work days due to illness and injuries)	Preparedness level for using these technologies in crisis – once each year	POWERGRID	Design and operation	All Packages
		Safety awareness raising for staff.	Training/awareness programs and mock drills	Number of programs and percent of staff /workers covered – once each year			
		Preparation of fire emergency action plan and training given to staff on implementing emergency action plan					

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
		Provide adequate sanitation and water supply facilities	Provision of facilities	Complaints received from staff /workers every 2 weeks			
Electric Shock Hazards	Injury/mortality to staff and public	Careful design using appropriate technologies to minimise hazards	Usage of appropriate technologies (number of injury incidents, lost work days)	Preparedness level for using these technologies in crisis – once a month	POWERGRID	Design and Operation	All Packages
		Security fences around substations	Maintenance of fences	Report on maintenance – every 2 weeks			
		Barriers to prevent climbing on/dismantling of transmission towers	Maintenance of barriers				
		Appropriate warning signs on facilities	Maintenance of warning signs				
		Electricity safety awareness raising in project areas	Training /awareness programs and mock drills for all concerned parties	Number of programs and percent of total persons covered – once each year			
Equipment specifications and design parameters	Release of chemicals and gases in receptors (air, water, land)	Processes, equipment and systems using cholofluorocarbons (CFCs), including halon, should be phased out and to be disposed of in a manner consistent with the requirements of the Government.	Process, equipment and system design	Phase out schedule to be prepared in case still in use – once in a quarter	POWERGRID	Operations	Substation Packages*

Project activity /stage	Potential impact	Proposed mitigation measure	Parameter to be monitored	Measurement and frequency	Institutional responsibility	Implementation schedule	Applicability
Transmission line maintenance	Exposure to electromagnetic interference	Transmission line design to comply with the limits of electromagnetic interference from overhead power lines	Required ground clearance (meters)	Ground clearance - once	POWERGRID	Operations	Transmission Line Tower Packages
Noise related	Nuisance to neighbouring properties	Substations sited and designed to ensure noise will not be a nuisance.	Noise levels (dB(a))	Noise levels at boundary nearest to properties and consultation with affected parties if any - once	POWERGRID	Operations	Substation Packages*

*Substation packages also include Transformer, Reactor, FSC / TCSC Packages