

Project: 400/220kV Tumkur(Pavagada), 400kV Mysore & 400/220kV Tumkur (Vasanthnarsapur)
Substation Pkg

Customer: Power Grid Corporation of India (POWERGRID)

Technical Specification for 500MVA Auto Transformer

Doc No. TB-393-316-001

Section-3: Project Details & General Technical Requirements

Rev. No. 00

SECTION-3
PROJECT DETAILS & GENERAL TECHNICAL REQUIREMENTS

SITE INFORMATION

SI No	Particulars	Details
PROJECT DETAILS		
a)	Owner	Power Grid Corporation of India (POWERGRID)
b)	Customer	Power Grid Corporation of India (POWERGRID)
c)	Project Title	Substation Package for Extension of 400kV Tumkur Pooling station (Pavagada) (including transformer & Reactor), Extension of 400/220kV Mysore Substation and Extension of 400/220kV Tumkur (Vasanthnarsapur) (Including Transformer) under Transmission System for Ultra Megar Solar Power Park (2000MW) at Tumkur (Pavagada), Karnataka-Phase-II (Part-A)
d)	Location	1. Tumkur (at Pavagada), Karnataka 2. Mysore, Karnataka 3. Tumkur (at Vasanthnarsapur) (Existing Madhugiri Substation), Karnataka
e)	Transport Facilities	Road/ Train/Air Connectivity: Nearest Railway Station 1. Tumkur (at Pavagada), Karnataka: Hindupur (AP)/ Bengaluru 2. Mysore, Karnataka: Mysore/ Mysore 3. Tumkur (at Vasanthnarsapur) (Existing Madhugiri Substation), Karnataka: Tumkur/ Bengaluru
SITE CONDITIONS		
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient emp.	50°C
d)	Design reference temp.	50°C
e)	Average Humidity	Shall be provided during detailed engineering.
f)	Special corrosion conditions	Shall be provided during detailed engineering.
g)	Solar Radiation	Shall be provided during detailed engineering.
h)	Atmospheric UV radiation	Shall be provided during detailed engineering.
i)	Altitude above sea level	Less than 1000 meter above sea level (MSL)
j)	Snow Fall	NIL
k)	Seismic Zone	As per IS 1893

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l)	Wind Zone	As per IS 875
MAIN ELECTRICAL PARAMETERS:		
a)	Fault Levels	Tumkur (Pavagada) 400kV: 50kA for 1 sec. 220kV: 40kA for 1 sec. Mysore 400kV: 40kA for 1 sec. Tumkur (Vasanthnarsapur i.e. existing Madhugiri SS) 400kV: 50kA for 1 sec 220kV: 40kA for 1 sec
a)	Creepage Distance	25mm/kV

1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

- 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 unless included in the list of exclusions.
- Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.
- Whenever a material or article is specified or described 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.
- In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.
- The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.
- The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.
- All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.

- h) The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.

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 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 Section-2 (Section-2A & 2B), unless specifically mentioned in the specification.
- 3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.
- 3.4 The Bidder 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/CIGRE/IEEE/NEMA.
- 3.5 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.
- 3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Section-2 (Section-2A & 2B) individual sections for various equipment shall also be accepted; however the salient points of difference shall be clearly brought out in additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under Section-2A/ individual sections for various equipment shall be subject to Purchaser's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

- 4.1 All equipment shall perform satisfactorily under various electrical, electromechanical and meteorological conditions of the site of installation.
- 4.2 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.
- 4.3 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.
- 4.4 The equipment shall also comply with 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.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the BHEL/POWERGRID shall be discussed and finalised by the BHEL/POWERGRID at the time of award. An indicative list of such drawings and documents for transformer are enclosed in **Annexure-A**. The Bidder shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Bidder 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 Purchaser. The Bidder shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Bidder 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 Each drawing submitted by the Bidder shall be clearly marked with the name of the POWERGRID, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID 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 along with 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.

5.4 The review of these data by the BHEL/POWERGRID 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 BHEL/POWERGRID 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 BHEL/POWERGRID shall not be considered by the Bidder, 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 Bidder's risk. The Bidder may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the BHEL/POWERGRID. Approval of Bidder's drawing or work by the

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BHEL/POWERGRID shall not relieve the Bidder of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Bidder after final process including review and approval by the BHEL/POWERGRID 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 Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalized at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

Sr. No.	Description	Schedule
i)	Approval/comments/by Purchaser on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format, GA and foundation in AutoCAD also for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports a) Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation) b) Routine Test Reports (one copy for each substation)	2 weeks from the date of final approval -do-
vi)	Furnishing of instruction/operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	As per agreed schedule
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 Bidder may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or

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adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

2) All drawings should be submitted 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.

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 supplier to BHEL/POWERGRID.

5) The Bidder shall furnish to the BHEL/POWERGRID catalogues of spare parts.

6) All As-built drawings/ documents shall be certified by site indicating the changes before final submission.

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 Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Bidder shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Bidder.

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 BHEL/POWERGRID.

- 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 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 Bidder'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 Bidder 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 supplier 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/ Supplier has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help Purchase/BHEL/POWERGRID in establishing equivalent Indian make and Indian Contractor/ Supplier. The same shall be applicable to other consumables too.
- 6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipment shall be in line with the procedure given at **Annexure-B and C** respectively.

6.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment 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. On-off 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.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

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. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide 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: 13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

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 Purchaser. The rating plate of each equipment shall be according to IEC requirement.

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 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 successful Operation, shall be furnished by the supplier unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The Bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor 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 supplier 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

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done that it facilitates easy field assembly and maintenance.

- 7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.
- 7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID 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 supplier's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following.
- a) His organization structure for the management and implementation of the proposed quality assurance programme.
 - b) Documentation control system;
 - c) Qualification data for bidder's key personnel;
 - d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
 - e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
 - f) Control of non-conforming items and system for corrective actions;
 - g) Inspection and test procedure both for manufacture and field activities.
 - h) Control of calibration and testing of measuring instruments and field activities.
 - i) System for indication and appraisal of inspection status;
 - j) System for quality audits;
 - k) System for authorising release of manufactured product to the BHEL/POWERGRID.
 - l) System for maintenance of records;
 - m) System for handling storage and delivery; and
 - n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered BHEL/POWERGRID or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the supplier/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Purchaser/POWERGRID/BHEL inspection of equipment/material.

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION 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 Bidder along with equipment / material drawings.

Type Tests on Transformer & Reactor fittings: The test reports submitted, shall be of the tests conducted within last 10 (ten) years prior to the originally scheduled date of bid opening i.e. **08.08.2016**. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening i.e. **08.08.2016**, the contractor/ Supplier shall repeat these test(s) at no extra cost to the BHEL/POWERGRID. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant. Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) 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 BHEL/POWERGRID. The Contractor shall intimate the Purchaser the detailed program about the tests at least two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

- 9.3 For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminium tube and junction boxes, type test reports are not required to be submitted for the makes indicated at **Annexure-D** POWERGRID approved list of sub-vendors. For the new makes (other than those indicated at **Annexure-D** POWERGRID approved list of sub-vendors), type test reports as per relevant standard shall be submitted for purchaser's approval.
- 9.4 The BHEL/POWERGRID, his duly authorised representative and/or outside inspection agency acting on behalf of the BHEL/POWERGRID shall have at all reasonable times free access to the Bidder's premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Bidder shall

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obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

- 9.5 The Bidder shall give the BHEL/POWERGRID/Inspector fifteen (15) days written notice for on-shore and six (6) weeks' notice for off-shore material being ready for joint testing including Bidder and POWERGRID. Such tests shall be to the Bidder's account except for the expenses of the Inspector. The BHEL/POWERGRID /Inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.
- 9.6 The BHEL/POWERGRID or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. Bidder 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 BHEL/POWERGRID /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.
- 9.7 When the factory tests have been completed at the Bidder's works, the BHEL/POWERGRID/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the BHEL/POWERGRID/inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the BHEL/POWERGRID/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.
- 9.8 In all cases where the Contract provides for tests whether at the premises or at the works of the Bidder, the Bidder 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 BHEL/POWERGRID /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 BHEL/POWERGRID/Inspector or to his authorised representative to accomplish testing.
- 9.9 The inspection by BHEL/POWERGRID and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the

agreed quality assurance programme forming a part of the Contract.

9.10 The BHEL/POWERGRID 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.

9.11 The BHEL/POWERGRID reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the BHEL/POWERGRID.

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 Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser 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 provided by the Contractor, free of cost.

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

10.3 The Bidder 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 BHEL/POWERGRID 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 BHEL/POWERGRID, the Bidder shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser 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 Bidder 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 Bidder. Purchaser 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 piping 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. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. 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. 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**.
- 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 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 treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- 12.2.4 The galvanized steel shall be subjected to six 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 Galvanized material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and 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 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 equipment. Glossy white color inside the equipment /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 equipment.

12.3.5 In case the Bidder 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 along with the Bids for Purchaser's review & approval.

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

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Air Conditioning systems

Sr. No.	PIPE LINE	Base color	Band color
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line –	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
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

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.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on Bidder's drawings or as directed by the BHEL/POWERGRID or his representative, the Bidder 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.

13.2 BHEL/POWERGRID may engage Bidder's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Bidder shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The Bidder shall have to ensure that the hard and flat indoor and

outdoor storage areas are in place prior to commencement of delivery of material at site. Bidder shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only. Storage of equipment on top of another one is not permitted if the wooden packing is used. 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 BHEL/POWERGRID. Bidder 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, Bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses. Bidder shall also do necessary adjustments/alignments necessary 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 Bidder at his own expense.
- 13.6 Bidder shall be responsible for examining all the shipment and notify the BHEL/POWERGRID immediately of any damage, shortage, discrepancy etc. for the purpose of BHEL/POWERGRID's information only. The Bidder shall submit to the BHEL/POWERGRID every week a report detailing all the receipts during the weeks. However, the Bidder 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 Bidder.
- 13.7 The Bidder shall be fully responsible for the equipment/ material until the same is handed over to the BHEL/POWERGRID in an operating condition after commissioning. Bidder shall be responsible for the maintenance of the equipment/ material while in storage as well as after erection until taken over by BHEL/POWERGRID, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 13.8 Where material/ equipment is unloaded by BHEL/POWERGRID before the Bidder arrives at site or even when he is at site, BHEL/POWERGRID by

right can hand over the same to Bidder and there upon it will be the responsibility of Bidder to store the material in an orderly and proper manner.

- 13.9 The Bidder 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 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 Purchaser. 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.

14.0 TOOLS

14.1 TOOLS & PLANTS (T&P)

The Bidder 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 Bidder.

14.2 SPECIAL TOOLS AND TACKLES

The bidder shall include in its proposal the deployment of 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. However a list of all such devices should be indicated in the relevant schedule provided in the Bid Price Schedule.

In addition to this, the Bidder shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the BHEL/POWERGRID during the operation of these equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

15.0 AUXILIARY SUPPLY

- 15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" having the following parameters. 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.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connectio
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
48V	—	DC	—	2 wire system (+) earthed

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

16.0 SUPPORT STRUCTURE (If in the scope of Bidder)

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765 kV, 420 kV and 245 kV 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 Support structure shall meet the following mandatory requirements:

16.2.1 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.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to IS: 5561 & NEMA CC1 and shall be made of materials listed below:

- | | | |
|----|--|---|
| a) | For connecting ACSR conductors | Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617 |
| b) | For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS:617 with 2mm thick bimetallic liner and all test shall conform to IS:617 |
| c) | For connecting G.I | Galvanised mild steel shield |
| d) | i) Bolts, nuts & Plain, washers | i) Electrogalvanised for sizes below M12, for others hot dip galvanised. |
| | ii) Spring washers items | ii) Electro-galvanised mild for steel suitable for atleast |

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'a' to 'c'

service condition-3 as per
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- 17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. 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 equipment as specified in any 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 of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic 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 4" 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 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

- 17.11.1 Clamps and connectors should be type tested 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 as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. The requirement of test conducted within last ten years shall not be applicable).
- i) Temperature rise test (maximum temperature rise allowed is 35°C over

50°C ambient)

- ii) Short time current test
- iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level Clamps)
- iv) Resistance test and tensile test

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-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. 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.
- 18.3 A canopy and sealing arrangements for operating rods shall be provided inmarshalling boxes / Control cabinets to prevent ingress of rain water.
- 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. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.
- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene 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.
- 18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by mean 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 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.

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- 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 For illumination, a fluorescent tube or CFL of approximately 9 to 15 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 Positive 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 a) 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
b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Deleted.

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 inter-phase 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 preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.
- 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.
- 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, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- | | |
|---------------------------------------|---|
| a) All circuits except CT/PT circuits | Minimum of 2 nos. of 2.5 sq mm Copper flexible. |
| b) All CT/PT circuits | Minimum of 4 nos. of 2.5 sq mm Copper flexible. |
- 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 supplier 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 overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.
- 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.

21.0 LAMPS & SOCKETS

21.1 Sockets

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

21.2 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection 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, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse 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 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.

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

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.

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:

- 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.

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23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Bidder shall perform any additional test based on specialties of the items as per the field Quality Plan/ Instructions of the equipment without any extra cost to the BHEL/POWERGRID. The Bidder shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser 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.

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ANNEXURE-A

INDICATIVE LIST OF DRAWINGS FOR TRANSFORMER

1. Outline General Arrangement (OGA) drawing of transformer
 - a) Plan
 - b) Elevation
 - c) End View
 - d) Neutral formation of three phase bank
 - e) Delta formation of three phase bank

List of all accessories with detailed weights, dimensions, clearances, spacing of wheels in direction, center of gravity, location of cooler etc.
2. Foundation Plan showing reaction at points of support, clamping arrangement & location of jacking pads.
3. Technical Data requirement sheet of transformer
4. Over fluxing withstand duration curve
5. Inrush current characteristics while charging from HV & IV side respectively.
6. Schematic wiring and diagram of cooling arrangement along with write up on scheme
7. Schematic wiring and diagram of OLTC along with write up on scheme
8. Mounting Arrangement and wiring diagram of remote WTI along with write up
9. Bushing Drawing showing electrical and mechanical characteristics
 - a) HV Bushing
 - b) IV Bushing
 - c) LV Bushing
 - d) Neutral bushing
10. Outline and General Arrangement of Cooler Control Cabinet
11. Cooler Control cabinet schematic and wiring diagram
12. Magnetisation Characteristics of bushing CTs
13. Hysteresis Characteristics of iron core
14. Rating and Diagram Plate
15. Overall Transport dimension drawing of transformer
16. Drawing showing typical sectional view of the windings with details of insulation, cooling circuit method of cooling and core construction etc.
17. Oil Flow Diagram
18. Valve Schedule Plate drawing
19. Twin Bi-directional Roller
20. Connection Diagram of all protective devices to marshalling box showing physical location
21. List of spares
22. Technical Literature on all fittings and accessories.

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23. Calculation to support short circuit withstand capacity of transformer
24. Calculation of hot spot temperature
25. Value of air core reactance with a typical write-up of calculation
26. Oil sampling Bottle details
27. Typical heating and cooling curves
28. OGA of RTCC panel
29. RTCC panel schematic and wiring diagram
30. Outline and General Arrangement drawing of Common Marshalling Box
31. Schematic wiring and diagram of Common Marshalling Box
32. OGA of Ladder for transformer
33. Transformer oil storage tank drawing
34. 33 KV Neutral CT drawing and technical data sheet
35. Customer inspection schedule
36. Test procedure of transformer
37. Type test Reports of transformer
38. O & M manual of transformer

ANNEXURE-B
CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

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

2. Test Levels:

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

3. Test Methods for RIV:

- 3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.
- 3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 - 1964, except otherwise noted herein.
- 3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.
- 3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.
- 3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.
- 3.6 The RIV measurement may be made with a noise meter. A calibration procedure
of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction

voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 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 four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 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 Purchaser's

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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 100microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

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ANNEXURE-C

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (for 132kV and above) shall be carried out along with supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's premises/POWERGRID 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 Purchaser. 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 Purchaser.

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ANNEXURE-D

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

S.NO.	ITEM DESCRIPTION	MAKE
1.	OUT DOOR RECEPTACLES	CGL/ B&C / BCH / SAKTI, CHENNAI/INDO ASIAN
2.	TREFOIL CLAMP	MOULDED FIBRE GLASS PRODUCTS,
3.	DIESEL ENGINE	CUMMINS / RUSTON & HORNSBY
4.	ALTERNATOR	AVK / KIRLOSKAR / STAMFORD
5.	MOTORS	KEC / SIEMENS/ NGEF/CROMPTON/ABB
6.	CABLE GLANDS	SUNIL & CO. / ARUP/ COMET / QPIE
7.	JUNCTION BOX	SARVANA / ECS / C&S /VIKAS
8.	LIGHTING FIXTURES	PHILLIPS/CGL/BAJAJ
9.	AC SR CONDUCTOR	STERLITE/APAR/HVPL/ SHARAVATHY/HIREN
10.	AAC CONDUCTOR (BULL)	STERLITE/CABCON
11.	TERMINAL CONNECTOR	NOOTAN ENGINEERING VADODARA / M/S MILIND ENGG MUMBAI / M/S PEEVEE ENGG. BANGALORE / M/S KLEMMEN ENGG. CORP., CHENNAI / M/S VINAYAK TRANSMISSION PRODUCTS PVT. LTD., MUMBAI / NANJING TERUI POWER MATERIAL CO. LTD / EXALT, MUMBAI / ASBESCO, KOLKATA / VENSUN, CHENNAI / MEGHA, CHENNAI
12.	G.S. EARTHWIRE	SHARAVATHY/BHARAT WIRE ROPES / RAMSWARUP
765KV CLASS TRANSFORMER & REACTOR		
13.	BUCHHOLZ RELAY	EMB CONTROL AB, SWEDEN / M/S CEDESPE, ITALY / ETL ITALY / SHENYANG YINHAI ELECTRICAL CO., LTD
14.	PRESSURE RELIEF DEVICE	QUALITROL CORPORATION, USA / MESSKO, GERMANY / SHENYANG STI ELECT TECH CO. LTD / SHENYANG KEQI ELECTRICAL EQUIPMENT CO., LTD.
15.	MAGNETIC OIL LEVEL	COMEM, ITALY / TAIJIN INDUSTRIES, SOUTH KOREA / SHENYANG YINHAI ELECTRICAL CO., LTD / MESSKO , GERMANY / QUALITROL, USA
16.	AIR CELL (FLEXIBLE AIR SEPARATOR)	M/S PRONAL FRANCE / FUJIKURA, JAPAN / PRONAL ASIA, MALAYSIA / SHENYANG HONGDA GENERAL RUBBER FACTORY / BAODING XINKE RUBBER PRODUCT INSTITUTE, CHINA /
17.	OTI & WTI	MESSKO , GERMANY / QUALITROL AKM, SWEDEN / HONGZHAOU KEHONG INSTRUMENTS / DALIAN SHIYOU ELECTRIC POWER TECHNOLOGY CO., LTD
18.	OIL PUMP	GEA / BEIJING FUTE DISC MOTOR FAN LTD./ ABB, SWEDEN / FLOWWELL PUMPS & METERS.

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		UNTIL, BANGALORE
19	COOLING FAN AND MOTOR ASSEMBLY	M/S CALIFORNIA TURBO,USA / ZIEHL-ABEGG SVER / ZHEJIANG MINGXIN FAN CO., LTD.
UPTO 400KV CLASS TRANSFORMER & REACTOR		
20	BUCHHOLZ RELAY	M/S ATVUS KOLTATA / M/S INSTRUMENTS & CONTROL VADODARA / M/S A.J.SERVICES (PRAYOG) BOMBAY / M/S WEIR ELECTRIC, UK / M/S VEB, GERMANY / M/S ASPE, ITALY
21	PRESSURE RELIEF DEVICE	M/S SKURUT UDYOG, PUNE / M/S QUALITROL COMPANY USA / M/S MESSKO, GERMANY
22	MAGNETIC OIL LEVEL	M/ S SUKRUT UDYOG PUNE / M/S YOGYA ENTERPRISES, JHANSI / M/S MESSKO, GERMANY
23	AIR CELL (FLEXIBLE AIR SEPARATOR)	M/ S THE RUBBER PRODUCTS MUMBAI / M/S UNIRUB TECHNO PUNE THRO SUKURUT UDYOG PUNE / M/S PRONAL FRANCE
24	OTI & WTI	M/S PERFECT CONTROL CHENNAI / M/S PRESIMEASURE BANGALORE / M/S AKM, SWEDEN / M/S ACCURATE CONTROL, UK / M/S MESSKO, GERMANY
25	OIL PUMP	M/ S BEST & CROMPTON ENGG. LTD., CHENNAI / M/S FLOW WEL BANGALORE / M/S CROMPTON GREAVES, MUMBAI / M/S SPP, UK
26	COOLING FAN AND MOTOR ASSEMBLY	M/S MARATHON LTD KOLKATA / M/S KHAITAN PVT LTD KOLKATA / M/S EPC – KOLKATA
27	UNIT COOLER	M/S LUVATA Soderkoping AB, SWEDEN/ M/S GEI HAMON BHOPAL / M/S SERKHEAT TRANFER, UK / M/S TADA ELECTRIC JAPAN / M/S BHEL, BHOPAL / M/S LUVATA HEAT TRANSFER SOLUTION (WUXI), CHINA

NOTE:

1. For a new make other than above/POWERGRID approved list of sub vendor, type test Reports as per relevant standard shall be submitted for Purchaser's approval.
2. Items listed for 765kV Transformer & Reactor shall be also applicable for up to 400kV Transformer & Reactor.

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SECTION-4
GUARANTEED TECHNICAL PARTICULARS

1. Technical Particulars/ Parameters for 500MVA, 400/220/33kV 3-Phase Auto Transformer

Sr. No.	Description	Unit	Data to be furnished by Bidder
1.1	Rated Capacity		
	(i) HV	MVA	
	(ii) IV	MVA	
	(iii) LV (Tertiary): Active + Reactive loading	MVA	
1.2	Voltage ratio (Line to Line)		
1.3	Single / Three Phase Design		
1.4	Applicable Standard		
1.5	Frequency	Hz	
1.6	Cooling & Percentage Rating at different cooling		
1.7	Type of Transformer		
1.8	Impedance at 75 °C		
	(i) HV-IV		
	Max. Voltage tap	%	
	Principal tap	%	
	Min Voltage tap	%	
	(ii)HV-LV		
	Principal tap (minimum)	%	
	(ii)IV-LV		
	Principal tap (minimum)	%	
1.9	Tolerance on Impedance (HV-IV)	%	
1.10	Service		
1.11	Duty		
1.12	Overall Capacity		
1.13	Temperature rise over 50deg C ambient Temp		
	(i) Top oil measured by thermometer	°C	
	(ii) Average winding measured by resistance method	°C	
1.14	Windings		
	(i) System Fault level		
	HV	kA	
	IV	kA	
	LV	kA	

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	(ii) Lightning Impulse withstand Voltage		
	HV	KVp	
	IV	KVp	
	LV	KVp	
	Neutral	KVp	
	(iii) Switching Impulse withstand Voltage		
	HV	KVp	
	(iv) One Minute Power Frequency Withstand Voltage		
	HV	KVrms	
	IV	KVrms	
	LV	KVrms	
	Neutral	KVrms	
	(v) Neutral Grounding		
	(vi) Insulation		
	HV		
	IV		
	LV		
	(vii) Tertiary Connection		
	(viii) Tan delta of winding	%	
1.15	Vector Group (3-ph) (unless specified differently elsewhere)		
1.16	Tap Changer		
	(i) Tap Range & No. of steps		
	(ii) Location of Tap changer		
	(iii) Design		
	(iv) Tap control		
1.17	Bushing		
	(i) Rated voltage		
	HV	kV	
	IV	kV	
	LV	kV	
	Neutral	kV	
	(ii) Rated current (Min.)		
	HV	A	
	IV	A	
	LV	A	
	Neutral	A	
	(iii) Lightning Impulse withstand Voltage		
	HV	KVp	
	IV	KVp	

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	LV	KVp	
	Neutral	KVp	
	(iv) Switching Impulse withstand Voltage		
	HV	KVp	
	IV	KVp	
	(v) One Minute Power Frequency withstand Voltage		
	HV	KVrms	
	IV	KVrms	
	LV	KVrms	
	Neutral	KVrms	
	(vi) Minimum total creepage distances		
	HV	mm	
	IV	mm	
	LV	mm	
	Neutral	mm	
	(vii) Tan delta of bushings		
	HV	%	
	IV	%	
	LV	%	
	Neutral		
	(viii) Max Partial discharge level at Um		
	HV	pC	
	IV	pC	
	LV	pC	
	Neutral		
1.18	Max Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	
1.19	Max Noise level at rated voltage and at principal tap on full load and all cooling active	dB	
1.20	Maximum Permissible Losses for Auto Transformer		
	(i) Max. No Load Loss/ Iron Loss at rated voltage and frequency	kW	
	(ii) Max. Load Loss/ Copper Loss at rated current and at 75°C	kW	
	(iii) Max. Auxiliary Loss/ Cooler Loss at rated voltage and frequency	kW	

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Notes:

1. For parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers / Reactors are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)**".

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1. Technical Particulars/ Parameters for Current Transformer (On each phase) for 3-ph 500MVA, 400/220/33 kV Transformers

Description	Current Transformer Parameters (Transformer)		
	HV Side	IV Side	Neutral Side
(a) Ratio			
Core 1			
Core 2			
(b) Minimum knee point voltage or burden and accuracy class			
Core 1			
Core 2			
(c) Maximum CT Secondary Resistance			
Core 1			
Core 2			
(d) Application			
Core 1			
Core 2			
(e) Maximum magnetization current (at knee point voltage)			
Core 1			
Core 2			

NOTE:

i) For TPS class CT's, Dimensioning parameter "K", Secondary VA shall be considered 1.5 and 20 respectively. Class (for the relevant protection and duties) as per IEC 60185.

ii) Rated continuous thermal current rating shall be 200% of rated primary current.

iii) Parameters of WTI CT for each winding shall be provided by the contractor.

iv) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.

v) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

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SECTION-5 TECHNICAL CHECK LIST

Technical Checklist for information to be furnished with technical offer. Return this technical checklist as a part of technical offer duly signed

BHEL ENQUIRY. NO.:

BIDDER OFFER REF.:

It is to be noted that,

- The technical offer shall not be considered if this technical checklist duly filled, and signed are not enclosed with this technical offer.
- Bidder shall ensure the completeness of their technical offer in this regard.

Sr. No.	Description	Reply by Bidder	
1	Technical Qualifying Requirements		
1.1	Documents for meeting qualifying criteria submitted with the technical offer. *The evaluation of bidder against qualifying criteria specified under clause 1.5 of Section-1 of technical specification shall be based on the documentary proof submitted by bidder along with the technical offer.	Confirmed	Yes/ No
1.2	The bid shall be submitted by the Supplier/ Manufacturer only. The bidder's scope includes supply and services i.e. supervision of unloading, installation, testing and commissioning etc.	Confirmed	Yes/ No
1.3	All the documents shall be submitted in English. Translated pages should be attested by the bidder. All the dimensions shall be in SI units.	Confirmed	Yes/ No
2	Un-priced Bill of Quantities		
2.1	Confirm that all items have been quoted. *Confirmation shall be done by writing "Quoted" against each item. In case, if any item has not been quoted, the same shall be confirmed by writing "Not quoted" and reasons for the same is specifically brought out in Schedule of Technical Deviation	Confirmed	Yes/ No
2.2	The Specification envisages design, type	Confirmed	Yes/ No

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	testing, engineering, manufacture, testing, delivery at site including all materials, accessories, spares, supervision of unloading, erection, testing and commissioning of the equipment specified/ 500MVA, 400/220/33kV Auto Transformer to the satisfaction of BHEL/POWERGRID.		
2.3	Any other item/ service required for the execution for the complete work is deemed to be included in the offer, whether specifically mentioned in the specification or not. List of items required for completeness of work is to be attached, if required and prices for same deemed to be included in prices of main items.	Additional Supply(s)/ Service(s) required	Yes/ No
3	Technical Requirements		
3.1	Maximum Permissible losses for Autotransformer		
3.1.1	Max. No Load Loss/ Iron Loss at rated voltage and frequency (kW)	90kW	Yes/ No
3.1.2	Max. Load Loss/ Copper Loss at rated current and at 75°C (kW)	500kW	Yes/ No
3.1.3	Max. Auxiliary Loss/ Cooler Loss at rated voltage and frequency (kW)	15kW	Yes/ No
3.1.4	Bidder to ensure the Autotransformer with above specified losses.	Confirmed	Yes/ No
3.2	Guaranteed Losses and Liquidated Damage due to higher loss: The maximum loss at rated condition (voltage, current and frequency, as applicable) for Auto Transformer shall be corrected in accordance with IEC-60076 for the purpose of comparison of maximum losses with measured losses for levy of liquidated damages. If during factory tests, measured loss (es) are found to be more than the specified maximum value(s) (specified in section-1, clause 1.2.2), BHEL/POWERGRID at his discretion may accept or reject Auto Transformer after assessing the liquidated damages (LD) against the contract as per	Confirmed	Yes/ No

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	rates given in section-1, clause 1.2.2.3 and such amount shall be deducted from the contract price or otherwise recovered from Bidder. No cost benefit shall be considered in case measured losses are less than the specified maximum losses.		
3.3	Criterion for calculating Liquidated damage: Differential losses = Losses measured at the time of testing-corresponding losses (specified in section-1, clause 1.2.2) (corrected in accordance with IEC-60076)	Confirmed	Yes/ No
3.5	Liquidated Damage due to differential losses on pro-rata basis: If measured losses are exceeding maximum specified guaranteed losses (specified in clause 1.2.2 above), value by 0 to +5%, the details for liquidated damages on pro-rata basis for the performance of Auto Transformer shall be as follows, 1. Rs.1, 67,715/kW differential No Load Loss/ Iron Loss 2. Rs.3, 69,950/KW differential Load Loss/ Copper Loss 3. Rs.2, 46,640/KW differential Auxiliary Loss/ Cooler Loss	Confirmed	Yes/ No
3.6	Liquidated damages shall be applied in the following manner depending on the variation of losses with respect to the maximum values: a) Measured losses exceeding Maximum value by 0 to +5%: Rates of LD mentioned above b) Measured losses exceeding Maximum value by > +5% to +10%: Twice the rates of LD mentioned above c) Measured losses exceeding Maximum value by > +10% to +15%: Four times the rates of LD mentioned above	Confirmed	Yes/ No

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	However, the equipment under no circumstances shall be accepted if the measured losses in each category exceed by more than +15 percent of the Maximum losses (as specified in clause 1.2.2 above) at rated conditions.		
4	Technical Particulars		
4.1	Rated Capacity		
	(i) HV	500MVA	Yes/ No
	(ii) IV	500MVA	Yes/ No
	(iii) LV (Tertiary): Active + Reactive loading	1/3 rd of rated capacity of HV winding	Yes/ No
4.2	Voltage ratio (Line to Line)	400/220/33kV	Yes/ No
4.3	Single / Three Phase Design	3 (Three)	Yes/ No
4.4	Applicable Standard	IEC 60076	Yes/ No
4.5	Frequency	50Hz	Yes/ No
4.6	Cooling & Percentage Rating at different cooling	ONAN/ONAF/(OF AF or ODAF) : 60% / 80%/100% OR ONAN/ONAF1/O NAF2: 60% / 80%/100% OR OFAF (with 5 x 25% unit cooler)	Yes/ No
4.7	Type of Transformer	Constant Ohmic impedancetype	Yes/ No
4.8	Impedance at 75 Deg C		
	(i) HV-IV		
	Max. Voltage tap	10.3%	Yes/ No
	Principal tap	12.5%	Yes/ No
	Min Voltage tap	15.4%	Yes/ No
	(ii)HV-LV		
	Principal tap (minimum)	60.0%	Yes/ No
	(ii)IV-LV		
	Principal tap (minimum)	45.0%	Yes/ No
4.9	Tolerance on Impedance (HV-IV)	As per IEC	Yes/ No

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4.10	Service	Outdoor	Yes/ No
4.11	Duty	Continuous	Yes/ No
4.12	Overall Capacity	IEC-60076-7	Yes/ No
4.13	Temperature rise over 50deg C ambient Temp		
	(i) Top oil measured by thermometer	50 °C	Yes/ No
	(ii) Average winding measured by resistance method	55 °C	Yes/ No
4.14	Windings		
	(i) System Fault level		
	HV	63kA	Yes/ No
	IV	40kA	Yes/ No
	LV	25kA	Yes/ No
	(ii) Lightning Impulse withstand Voltage		
	HV	1300KV _p	Yes/ No
	IV	950KV _p	Yes/ No
	LV	250KV _p	Yes/ No
	Neutral	95KV _p	Yes/ No
	(iii) Switching Impulse withstand Voltage		
	HV	1050KV _p	Yes/ No
	(iv) One Minute Power Frequency Withstand Voltage		
	HV	570KV _{rms}	Yes/ No
	IV	395KV _{rms}	Yes/ No
	LV	95KV _{rms}	Yes/ No
	Neutral	38KV _{rms}	Yes/ No
	(v) Neutral Grounding	Solidly grounded	Yes/ No
	(vi) Insulation		
	HV	Graded	Yes/ No
	IV	Graded	Yes/ No
	LV	Uniform	Yes/ No
	(vii) Tertiary Connection	Ungrounded Delta	Yes/ No
	(viii) Tan delta of winding	<0.5%	Yes/ No
4.15	Vector Group (3-ph) (unless specified differently elsewhere)	YN _a 0d11	Yes/ No
4.16	Tap Changer	OLTC	Yes/ No
	(i) Tap Range & No. of steps	± 10% of HV	Yes/ No

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		variation in the step of 1.25%, 16 steps	
	(ii) Location of Tap changer	On the 220 kV side of the series winding	Yes/ No
	(iii)Design	Constant flux voltage variation type as per cl. 6.2 of IEC 60076 part-I	Yes/ No
	(iv)Tap control	Full capacity - on load tap changer suitable for group / independent, remote /local electrical and local manual operation and bi-directional power flow	Yes/ No
4.17	Bushing		
	(i) Rated voltage		
	HV	420kV	Yes/ No
	IV	245kV	Yes/ No
	LV	52kV	Yes/ No
	Neutral	36kV	Yes/ No
	(ii) Rated current (Min.)		
	HV	1250A	Yes/ No
	IV	2000A	Yes/ No
	LV	3150A	Yes/ No
	Neutral	2000A	Yes/ No
	(iii) Lightning Impulse withstand Voltage		
	HV	1425KV _p	Yes/ No
	IV	1050KV _p	Yes/ No
	LV	250KV _p	Yes/ No
	Neutral	170KV _p	Yes/ No
	(iv) Switching Impulse withstand Voltage		
	HV	1050KV _p	Yes/ No
	IV	850KV _p	Yes/ No

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	(v) One Minute Power Frequency withstand Voltage		
	HV	695KV _{rms}	Yes/ No
	IV	505KV _{rms}	Yes/ No
	LV	105KV _{rms}	Yes/ No
	Neutral	77KV _{rms}	Yes/ No
	(vi) Minimum total creepage distances		
	HV	10500mm	Yes/ No
	IV	6125mm	Yes/ No
	LV	1300mm	Yes/ No
	Neutral	900mm	Yes/ No
	(vii) Tan delta of bushings		
	HV	<0.4%	Yes/ No
	IV	<0.4%	Yes/ No
	LV	<0.4%	Yes/ No
	Neutral	--	Yes/ No
	(viii) Max Partial discharge level at Um		
	HV	10pC	Yes/ No
	IV	10pC	Yes/ No
	LV	10pC	Yes/ No
	Neutral	--	Yes/ No
4.18	Max Partial discharge level at $1.58 * U_r / \sqrt{3}$	100pC	Yes/ No
4.19	Max Noise level at rated voltage and at principal tap on full load and all cooling active	80dB	Yes/ No
4.20	For parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.	Confirmed	Yes/ No
4.21	No external or internal Transformers / Reactors are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.	Confirmed	Yes/ No
4.22	Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.	Confirmed	Yes/ No
5	Technical Deviations		
5.1	Confirm that the Complete systems have been offered as per the requirements of	Confirmed	Yes/ No

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	Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.		
5.2	Schedule of Technical Deviation is enclosed.	Confirmed	Yes/ No
6	General Requirements		
6.1	Paint System and Procedure: Bidder to follow paint system and procure as per Clause 7.0 and Annexure-F of Section-2B.	Confirmed	Yes/ No
6.2	Grounding: Supply of grounding/ earthing material (except 40mm Dia MS rod and/or GI Flat) and supervision of erection/fixing of grounding/ earthing of Auto Transformer and its accessories shall be under bidder's scope, based on their design philosophy.	Confirmed	Yes/ No
6.3	Cabling: Cabling from Marshalling Box to Auto Transformer and its Cooling Bank is under scope of supply including glands, lugs, tags and ferruling etc. Termination schedule shall be submitted along with drawings.	Confirmed	Yes/ No
6.4	Auxiliary Supply: Terminals in marshalling box for external power supply coming into marshalling box shall be suitable to requirement.	Confirmed	Yes/ No
7	Type Testing		
7.1	The validity of Type Tests (except dynamic short circuit test) of Transformer shall be 5 years as on the originally scheduled date of bid opening i.e. 08.08.2016 , provided that offered transformer design is identical to the type tested transformer and same active materials (CRGO, Conductor and Insulation) of same grade & from the same sub-vendors are used. In case of any change of either active materials or sub-vendors, the type tests shall be carried out by the Bidder at no extra cost to BHEL. Transformer type test report from the same manufacturing plant shall only be acceptable. With regards to validity of dynamic short circuit test once conducted shall be applicable.	Confirmed	Yes/ No
7.2	Bidder should have successfully carried out Dynamic Short Circuit test on 315MVA,	Confirmed	Yes/ No

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	400/220/33kV Auto Transformer as on the originally scheduled date of bid opening i.e. 08.08.2016 and shall enclose the relevant Test Report/ Certificate along with bid. In case bidder has not successfully tested 315MVA, 400/220/33kV Auto Transformer for Dynamic Short Circuit test, their bid shall be considered technically non responsive. Further, design review of offered 400 kV Class Auto Transformer shall be carried out based on the design of short circuit tested 315MVA Auto Transformer.		
7.3	Type Tests on Transformer fittings: The test reports submitted, shall be of the tests conducted within last 10 (ten) years prior to the originally scheduled date of bid opening i.e. 08.08.2016 . In case the test reports are of the test conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening i.e. 08.08.2016 ., the Bidder shall repeat these test(s) at no extra cost to the BHEL/POWERGRID.	Confirmed	Yes/ No
7.4	In case type test reports are found to be technically unacceptable to BHEL/POWERGRID, the type test shall be conducted without cost and delivery implication to BHEL/POWERGRID.	Confirmed	Yes/ No
8	Inspection and Testing at Works		
8.1	The Bidder shall carry out a comprehensive inspection and testing programme during manufacture of the equipment as detailed in section-2B and section3 .	Confirmed	Yes/ No
9	Quality Plan		
9.1	The Bidder to follow valid and approved POWERGRD Quality Plan as per POWERGRID procedure. In case the bidder does not have POWERGRID approved Quality Plan, it will be the bidder's responsibility to get its Quality plan approved directly from POWERGRID.	Confirmed	Yes/ No
10	Erection, Testing and Commissioning at Site		
10.1	The Bidder shall supervise a comprehensive erection, testing and commissioning	Confirmed	Yes/ No

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	programme at site duly POWERGRID approved as detailed in section-2B and section3 .		
11	Information to be furnished by the Bidder		
11.1	Information/ documents to be furnished at the TENDER STAGE shall be as per Section-2B and Section-3 .	Confirmed	Yes/ No
12	Drawings/ Data Sheets		
	Bidder shall submit POWERGRID approved/Standard drawings wherever available for extension of approval.	Confirmed	Yes/ No
13.	Standards		
	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 i.e. 08.08.2016) of standard specified under Section-2A , unless specifically mentioned in the specification.	Confirmed	Yes/ No
14	Documents to be submitted with Technical Offer		
14.1	All documents as mentioned in Technical Specification are enclosed.	Confirmed	Yes/ No
14.2	OGA drawings are enclosed	Confirmed	Yes/ No
14.3	Documents for meeting Qualifying Requirements are enclosed.	Confirmed	Yes/ No
14.4	Bidder will submit detailed bar chart/ activity schedule indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning.	Confirmed	Yes/ No

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SECTION-6
SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list all the technical deviation/(s), clause wise with respect to technical specifications

Sr. No.	Page No.	Clause No.	Description	Deviations Sought	Reasons/ Justifications

Any deviation/(s) not specifically brought out in this section shall not be admissible for any commercial/ technical implication at later stage. Except the technical deviation/(s) listed in this schedule, Bidder's offer shall be considered in full compliance to technical specifications, irrespective of any such deviations indicated/ taken elsewhere in the submitted technical offer.

Date:

Bidder's Stamp and Signature

