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(A Govt. of Chhattisgarh undertaking) (A successor company of CSEB)
CIN- U40108CT2003SGC015820 GSTIN-22AADCC5773E1ZX

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TENDER SPECIFICATIONS

TR-21/02

(VOLUME – II OF III)

CONSTRUCTION OF 400/220 KV SUB-STATIONS AT DHARDEHI (DIST: BILASPUR) (Upgradation of existing 220/132 KV S/s Dhardehi) ON TURNKEY BASIS (Through E-Bidding)

RFx No. 8100022809

DATE & TIME OF PRE BID CONFERENCE
DATE: 24/12/2021 (TIME 11:30 HRS)

LAST DATE & TIME OF SUBMISSION OF TENDER
DATE: 07/01/2022 (TIME 14.00 HRS)

DUE DATE & TIME OF OPENING OF TENDER
DATE: 07/01/2022 (TIME 14.10 HRS)

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SECTION- GENERAL TECHNICAL REQUIREMENTS

1.0 FOREWORD

1.1 The provisions under this section are intended to supplement general requirements for the materials, equipments and services covered under other sections of tender documents. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

2.0 GENERAL REQUIREMENT

2.1 **The bidders shall submit all the technical requirements,data and information pertaining to 400/220KV S/S work being upgraded from 220/132 KV substation Dhardehi. Being the turn key project, the bidders have to perform designing and engineering of substation Layout, structures, equipments, SAS & civil works. All drawing & design related to 400/220 KV S/s work will be in the scope of the Contractor**.

2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.

2.3 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein the tender. **Alternate proposals offering similar equipments based on the manufacturer's standard practice may also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the CSPTCL**. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule, will not be considered as valid deviation.

2.4 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

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 date of bid opening) of standard specified under this section, 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 compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

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 Annexure / individual sections for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out in additional information schedule along with English language version of such standard. The equipment conforming to standards other than specified under Annexure / individual sections for various equipments shall be subject to Purchaser's approval.

3.7 The bidder shall clearly indicate in his bid the specific standards inaccordance with which the works will be carried out.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEINGFURNISHED

4.1 The 400KV system is being designed to limit the switching surge over voltage to 2.5pu and the power frequency over voltage to 1.5 pu. In case of the 400kV system, the initial value of the temporary over voltages could be 2.0 p u for 1 - 2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipments shall 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 Operating times of circuit breakers, and protective relays have been specified in respective sections.

4.4 EHV equipments and system shall be designed to meet the following
major technical parameters as brought out hereunder. The 33 KV equipments shall be designed for 72.5 KV insulation class.

4.4.1 **System Parameter**

S. No.	Description of Parameters	400 KV System	220 KV System	33 KV System
1	System operating voltage	400KV	220KV	33KV
2	Maximum operating voltage of the system(rms)	420KV	245KV	36KV
3	Rated frequency	50Hz	50Hz	50Hz
4	No. of phase	3	3	3
5	Rated insulation levels i) Full wave impulse withstand voltage(1.2/50 micro sec.) ii) Switching impulse withstand voltage (250/2500 micro sec.) dry and wet iii) One minute power frequency dry and wet withstand voltage (rms)	 1450KVp 1050KVp 630KV	 1050KVp ----- 460KV	 325KVp --- 140 KV
6	Corona extinction voltage	320KV	156KV	---

7	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 320KV rms for 400KV system and 156KV rms for 220KV	1000 micro-volt	1000 microvolt	
8	Minimum creepage distance	25 mm/KV (10500 mm)	25 mm/KV (6125mm)	25 mm/KV (1815 mm)
9	Min. clearances i) Phase to phase ii) Phase to earth iii) Sectional clearances	 4000 mm 3500 mm 6500 mm	 2100 mm 2100 mm 5000 mm	 320 mm 320 mm 3000 mm
10	Rated short circuit current for 1 sec. duration	50KA	50KA	25 KA
11	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

Note: The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

4.4.2 **Major Technical Parameters**

The technical parameters of the Bushings/hollow columns are given below. For other parameters and features respective technical sections should be referred.

(A) Technical Parameters of Bushings/Hollow Columns insulators/support insulators:

	For 400 kV System	For 220 kV System	For 33 kV System
a. Rated Voltage (kV)	420	245	72.5
b. Impulsewithstand±1425voltage (Dry & Wet) (kVp)	±1425	±1050	±325
c. Switching surge± 1050 withstand voltage (dry and wet) (kVp)	±1050	---	---
d.Power frequency 630with stand voltage (dry and wet) (kV rms)	630	460	140
e. Total creepage distance (mm)	10500	6125	1813

(f) Pollution Class-III Heavy (as per IEC 71) and as specified in Section-2 for all class of equipment.

(g) Insulator shall also meet requirement of and IEC-815 for 400 KV, 220 kV system, as applicable having alternate long & short sheds.

5.0 **ENGINEERING DATA AND DRAWINGS**

5.1 The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.

5.2 The list of drawings/documents which are to be submitted to CSPTCL shall be discussed and finalised by CSPTCL at the time of award. The Contractor shall necessarily submit all the drawings/ documents unless anything is waived. The Contractor shall submit 4 (four) sets of drawings/design documents/data/test reports as may be required for the approval of CSPTCL. Two sets of copies of approved drawings along with the literature/manual of the equipments shall be handed over to the Engineer in Charge of the work by the contractor.

5.3 **Drawings**

5.3.1 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

5.3.3 Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

5.4 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.5 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser 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.

6.0 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 finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval or comments by Purchaser on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments including both ways postal time).
iii)	Approval or comments	Within 3 weeks of receipt of resubmission.
iv)	Furnishing of distribution copies in bound volume (5 copies per substation and one copy for Corporate Centre)	2 weeks from the date of final approval
v)	Furnishing of distribution copies of test reports	
	(a) Type test reports (one copy per substation plus one copy for corporate centre)	2 weeks from the date of final approval
	(b) Routine Test Reports (one copy for each substation)	-do-

vi)	Furnishing of instruction1 operation manuals (4 copies per substation and two copies for corporate centre)	As per agreed schedule
vii)	RTFs of drawings (one set per substation and one set for corporate centre)	-do-
(viii)	CD/DVD highlighting installation and maintenance techniques/ requirements of circuit breaker & isolators (one per substation plus one for corporate centre)	-do-
(ix)	As built drawings & RTFs (Two sets per substation plus one set for corporate centre)	On completion of entire works
(x)	ROM optical disks for all As built drawings (one per sub-station plus one for corporate centre)	-do-

NOTE:

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) The drawings which are required to be referred frequently during execution should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.

(3) All major drawings should be submitted in Auto Cad Version 12 or better.

(4) 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.

(5) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Purchaser.

(6) The Contractor shall furnish to the Purchaser catalogues of spare parts.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 **The bidder shall note that the equipment offered by him in the bid as per the vendor's list of the tender only shall be accepted for supply.**

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

7.3 The Contractor 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.

7.4 The Contractor 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 Raipur or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by CSPTCL after discussion. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation 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 Purchaser.
(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 and1or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor1his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser's inspection of equipment/material

9.0 TYPETESTING, INSPECTION, TESTING & INSPECTIONCERTIFICATE

9.1 All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections. CSPTCL reserves the right to witness any or all the type tests. The Contractor shall intimate CSPTCL, the detailed program about the tests at least three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

9.2 The reports for all type tests and additional type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 1 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representative(s) of CSPTCL or PGCIL or NTPC. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020 . In case the test reports are not valid, the contractor shall repeat these test(s) at no extra cost to the CSPTCL. 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 additional type tests not carried out, same shall be carried out without any additional cost implication to the CSPTCL.
In case of 400 KV class instrument transformers, the following type tests should have validity period as on the date of bid opening.

i) Lightning Impulse Test
ii) Switching Impulse Test
iii) Multiple Chopped Impulse Test (For CT)
iv) Chopped Impulse Test (For CVT)

In case the test reports of these tests (for instrument transformers) as mentioned above are not valid as on the date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

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 Purchaser.

9.3 If CSPTCL intends to repeat the type tests and additional type tests on transformers, reactors, cables and battery chargers , test charges shall be payable as per provision of contract. The price of conducting type tests and additional type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. Type test reports as per relevant standard shall be submitted for CSPTCL's approval.

The Purchaser reserves the right to witness any or all the type tests. The purchaser also reserves the right to waive the repeating of type tests partly or fully and in case of waival, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser’s representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser

9.4 **INSPECTION OF EQUIPMENTS:-**

The pre despatch inspection of the equipments / materials shall be carried out at the works of the manufacturer in accordance with the inspection schedule. The equipment / material in the scope of supply to CSPTCL shall be inspected by CSPTCL’s authorised engineer / agency. For this purpose the contractor shall submit inspection call at least 15 days in advance, in the o/oED (P&P) CSPTCL. The expenses of CSPTCL Engineers for

inspection shall be borne by CSPTCL. In case on scheduled date of inspection, the material is not ready for inspection the call shall be treated as fake call and recovery of Rs. 25,000/- per such call or the actual cost whichever is higher shall be made from the contractor's bill.

10. TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the 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 testing equipments required for testing and commissioning shall be arranged by the Contractor as per approved test schedule..

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

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

11.0 HANDLING, STORING AND INSTALLATION

11.1 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

11.2 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

11.3 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

11.4 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost

11.5 PACKAGING & PROTECTION

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.. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor & purchaser takes no responsibility.All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 **FINISHING OF METAL SURFACES**

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the

specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing1grounding (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 gm1sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm1sq. 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 incopper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 **PAINTING**

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean Waterfollowed 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 colour of the paint shall be as per shade no: 697 (for outdoor)& 692 (for indoor) of IS-5 and inside shall be glossy white for all equipmentmarshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish andprotection 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 Air conditioning systems

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

13.1 **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.

13.2 **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 1 dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

13.3 **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) 1 IEC-947 (Part-I) 1 IS 12063 1 IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

13.4 **RATING PLATES, NAME PLATES AND LABELS**

13.4.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

13.4.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels 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.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 **AUXILIARY SUPPLY**

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

Normal Voltage connection	Variation in Voltage	Frequency in HZ	Phase/ Wire	Neutral
415V	+1- 10%	50 +1- 5%	3/4 Wire	Solidly Earthed.
240V	+1- 10%	50 +1- 5%	2 Wire	Solidly Earthed.
220V	l90Vto240 V	DC	-	Isolated 2 wire
48V		DC		2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to +1- 10%.

16.0 **SUPPORT STRUCTURE**

16.1. The Support structures for all equipments shall be supplied by the Contractor.

16.2 The support structures should be hot dip galvanized with minimum 610 gram/sq.m net of zinc.

16.3 In case of any deviation in this regard the bid is liable to be considered technically non responsive and shall be liable to be rejected.

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 A6of 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 wire	Galvanised mild steel shield
d) i) Bolts, nuts & Plain, washers	i) Electro galvanised for sizes below M12, for others hot dip galvanised.
ii) Spring washers for items 'a' to 'c'	ii) Electro-galvanised mild steel suitable for atleast service condition-3 as per IS: 1573

17.2 Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4" IPS (OD : 114.2 mm, ID: 97.18 mm) aluminium tube or suitable for Quad/Twin ACSR / AAAC Conductor (450 mm sub-conductor spacing and 250 mm Sub-Conductor spacing for 400 kV & 220 kV respectively). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. 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 aluminium 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. The design details of the joint shall be furnished to the Purchaser by the Contractor.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 12 mm thick. All ferrous parts shall be hot dip galvanised. Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm. The equipment pad shall have SIX bolts. T clamp shall have 12 bolts. For all types of clamps, the drawings shall be approved by the CSPTCL. For power transformer/reactor bushing clamps where aluminium conductor has to be connected to a copper stud, two separate clamps, one of Copper & other of Aluminium, shall be provided with bi-metallic strip joint on the plain pad surfaces of both clamps. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body 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 1.5 times current as the conductor and the temperature rise shall be 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. Corona extinction voltage for 400KV & 220 KV class clamps shall not be less than 320KV (rms) & 156 KV respectively and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

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 on three samples of offered clamps/connectors 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 five 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-439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. 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 aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements. A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes/Control cabinets to prevent ingress of rain water.

18.4 Cabinet boxes 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 damaged1cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged1cracked during

the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. 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 means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above the base of the marshalling Bay Room/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. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

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

18.8 For illumination of a 20 Watts fluorescent tube or 15 watts CFL shall be provided. The switching of the fittings shall be controlled by the door switch.

18.9 All control switches shall be of rotary switch type and Toggle1piano 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 BMKs shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door. The bus bars in the Bay Marshalling Kiosks shall be suitably covered to guard against unintentional contact.

18.12 a) The following routine tests alon gwith 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 Bay Room, 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 Auxiliary Switches (Applicable for isolators and circuit breakers)

The following type test reports on auxiliary switches shall be submitted for approval:

(a) Electrical endurance test - A minimum of 2000 operation for 2AD. C. with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop1visual defects1temperature rise test.

(b) Mechanical endurance test. A minimum of 1,00,000 operations with a subsequent checking of contact pressure test1visual examination.

(c) Heat run test on contacts.

(d) IR/HV test etc.

20. TERMINAL BLOCKS AND WIRING

20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 1100 V grade and have continuous rating to carrythe maximum expected current on the terminals. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts.

20.3 Terminal blocks for current transformer and voltage transformersecondary 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 forconnecting the following conductors on each side.

a)	All circuits except CT circuits	Minimum of two of 2.5 sq mm copper flexible.
b)	All CT circuits	Minimum of 4 nos. of 6 sq mm copper flexible.

All CT secondary wires from CT Junction Boxes to C & R panels shall be of 6 sq mm multi strand copper cables. All PT secondary wires from PT Junction Boxes to C & R panels shall be of 4sq mm multi strand copper cables.

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 At least 20 % spare terminals shall be provided on each panel1cubicle1box 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 First1bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.

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 AND SOCKETS

21.1 Lamps

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

21.2 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.

21.3 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.One Number hand lamp shall be provided for each bay marshalling room.

21.4 Switches and Fuses:

21.4.1 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 switch fuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.4.2 All fuses shall be of HRC cartridge type conforming to IS:9228mounted 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: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 2331IS 5621. The support insulators shall be manufactured and tested as per IS 25441IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable. The bidder may also offer composite silicon insulator, conforming to IEC-1109.

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 insulators1bushings1hollow 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 insulators1bushings 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. Insulator1bushing 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. The type test reports shall be submitted for approval. The validity of type test conducted should be governed by the guidelines issued for validity of type test

conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

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-online starting. These shall be capable of starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electro dynamic 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 at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.
b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P.1Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with 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.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS NOT IN VENDOR LIST

24.1 LT Switchgear(Items other than circuit breaker)

The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos. motor control center panels of the type and rating being offered which should be in successful operation as on date of issue of NIT.

The Switchgear items (such as fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design.

24.2 Station Transformers/ LT Transformer

The manufacturer, whose transformers are offered should have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformers of at least 33 KV class of 500 KVA or higher. The transformer should have been in successful operation for at least 2 years as on the date of issue of NIT

24.3 Fire Fighting System

The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number fire protection system of the each type described in (i), (ii) and (iii) below in installations such as power plants, substations, refineries, fertilizer plants or other industrial or commercial installations. Such systems must have been designed to the recommendations of Tariff Advisory Committee of India or any other international reputed authority like (FOC, London or NFPA, USA etc.) executed during last ten (6) years and should have been in successful operation for at least 2 years as on the date of issue of NIT.

(i) Automatic hydrant type fire protection system
(ii) Automatic high velocity or automatic medium velocity water spray type fire protection system/emulsifier system for 400kV Transformer/reactors.
(iii) Smoke detection system.

In case bidder himself do not meet the requirement of design, he can engage a consultant(s) who must have designed i) Automatic hydrant type fire protection system, ii) Automatic high velocity or automatic medium velocity water spray type fire protection system and iii) Smoke detection system, which must be in successful operation for at least two years as on the date of issue of NIT.

25.4 **Visual Monitoring System** : The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number Visual Monitoring System in a similar substations of M/S Power Grid Co. Ltd and the same shall be in successful operation for at least one year as on the date of issue of NIT.

25.5 **Substation Automation System Control Desk/Cabinet** : The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number Visual Monitoring System in a similar substations of CSPTCL,M/S Power Grid Co. Ltd or NTPC and the same shall be in successful operation for at least one year as on the date of issue of NIT.

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CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment (except Auto Transformer & Shunt Reactor) together with its associated connectors, where applicable, shall be tested for external corona 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).

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 micro volts.

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%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in micro volts.

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 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible coronadisappears. 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%, 115% and 130%. 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 f15.6 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.

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 inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

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

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (except Auto Transformer & Shunt Reactor) shall be carried out alongwith supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's premises 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 combination of the equipment. The seismic test procedure shall be furnished for approval of the Purchaser.

LIST OF SPECIFICATIONS- GENERAL STANDARDS AND CODES

India Electricity Rules
Indian Electricity Act
Indian Electricity (Supply) Act
Indian Factories Act

IS-5,	-	Colors for Ready Mixed Paints and Enamels.
IS-335,	-	New Insulating Oils.
IS-617,	-	Aluminium and Aluminium Alloy ingots & Castings for General Engineering Purposes
IS-1448 (P1 to P 145)	-	Methods of Test for Petroleumand itsProducts.
IS-2071 (P1 to P3)	-	Methods of High Voltage Testing.
IS- 12063	-	Classification of degreesof protectionprovided By enclosuresofelectricalequipment.
IS-2165 P1:1997	-	Insulation Coordination.
IS-6104 of Oil	-	Method of Test for Interfacial Tension against Water by the Ring Method
IS-6262	-	Method of test for Power factor & Dielectric Constant of Electrical Insulating liquids.
IS-6792	-	Method for determination of electric strength of insulating oils.
IS-5578	-	Guide for marking of insulated conductors.
IS-11353	-	Guide for uniform system of marking & identification of conductors & apparatus terminals.
IS-8263	-	Methods for Radio Interference Test on high voltage Insulators.
IS-9224 (Part 1,2&4)	-	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-601 17	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.
IEC-60376	-	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	-Radio Interference Test on High VoltageInsulators.	
IEC-60507	-Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.	
IEC-6094	-Common Specification for High Voltage Switchgear & Control gear Standards.	
IEC-60815	-Guide for the Selection of Insulators in respect of Polluted Conditions.	

IEC-60865 (P1 & P2)	-Short Circuit Current - Calculation of effects.
ANSI-C. 11NFPA.70	- National Electrical Code
ANSI-C37.90A (SWC)Tests	-Guide for Surge Withstand Capability
ANSI-C63.21, C63.3	-Specification for Electromagnetic Noise and - Field Strength Instrumentation 10 KHz to 1GHZ
C36.4ANSI-C68. 1	- Techniquest for Dielectric Tests
ANSI-C76. 11EEE21	-Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	- Specification for Sound Level Metres
ANSI-Y32-21C337.2	- Drawing Symbols
ANSI-Z55.11	- Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
N EMA- 107T apparatus	-Methods of Measurements of RIV of HighVoltage
N EMA-ICS-II	-General Standards for Industrial Control andSystems Part ICSI-109
CISPR- 1	- Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299. 1-1978h	- Quality Assurance Program Requirements
CSA-Z299.2-1979h	- Quality Control Program Requirements
CSA-Z299.3-1979h Requirements	- Quality Verification Program
CSA-Z299.4- 1979h	- Inspection Program Requirements

TRANSFORMERS AND REACTORS

IS:10028 (Part 2 & 3)	- Code of practice for selection, installation & maintenance of Transformers (P1:1993), (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	- Power Transformers
IS-3347 (part 1 to Part 8) Bushings	- Dimensions for Porcelain transformer for use in lightly polluted atmospheres.
IS-3639	- Fittings and Accessories for Power Transformers
IS-6600 immersedTransformers.	- Guide for Loading of Oil
IEC-60076 (Part 1 to Part 5)	- Power Transformers
IEC-60214	- On-Load Tap-Changers.
IEC-60289	
IEC- 60354	- Reactors.
IEC-60076-10 Levels	- Determination of Transformer and ReactorSound
ANSI-C571280	- General requirements for Distribution, Powerand Regulating Transformers
ANSI-C571290	- Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	- Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	- Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA

ANSI-C5792	-	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg CWinding Rise
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100		High Voltage Alternating Current Circuit breakers
IEC-60427	-	Synthetic Testing of High Voltage alternating current circuit Breakers.
IEC-6 1264	-	Pressurised Hollow Column Insulators

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND CAPACITOR VOLTAGE TRANSFORMERS

IS-2705- (P1 to P4)	-	Current Transformers.
IS:3156- (P1 to P4)	-	Voltage Transformers.
IS-4379	-	Identification of the Contents of Industrial Gas Cylinders
IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Voltage Transformers.
IEC-60358	-	Coupling capacitors and capacitor dividers.
IEC-60044-4	-	Instrument Transformers : Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line CarrierSystems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92 .2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors

BUSHING

IS-2099		-Bushings for Alternating Voltages above1000V
IEC-60137	-	Insulated Bushings for Alternating Voltages above 1000V

SURGE ARRESTERS

IS-3070 (PART2)		-Lightning arresters for alternating current systems :Metal oxide lightning arrestors without gaps.
IEC-60099-4	-	Metal oxide surge arrestors without gaps
IEC-60099-5	-	Selection and application recommendation
ANSI-C62.1	-	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	-	Surge Arresters

CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS

IS-722, IS-1248, IS-3231, 3231 (P-3)	-	Electrical relays for power system protection
IS:5039	-	Distributed pillars for Voltages not Exceeding 1000 Volts.
IEC-60068.2.2	-	Basic environmental testing procedures Part2: Test B:Dry heat
IEC-60529	-	Degree of Protection provided by enclosures.
IEC-60947-4- 1	-	Low voltage switchgear and control gear.
IEC-6 1095	-	Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2	-	Low Voltage Swtichgear and control gearassemblies

ANSI-C37.20	-	Switchgear Assemblies, includingmetal enclosed bus.
ANSI-C37.50	-	Test Procedures for Low Voltage AlternatingCurrent Power Circuit Breakers
ANSI-C39	-	Electric Measuring instrument
ANSI-C83	-	Components for Electric Equipment
IS: 8623: (Part 1 to 3)	-	Specification for Switchgear & Control Assemblies.
N EMA-AB	-	Moulded Case Circuit and Systems
N EMA-CS	-	Industrial Controls and Systems
NEMA-PB-1	-	Panel Boards
N EMA-SG-5	-	Low voltage Power Circuit breakers
N EMA-SG-3	-	Power Switchgear Assemblies
N EMA-SG-6	-	Power switching Equipment
NEMA-5E-3	-	Motor Control Centers
1248 (P1 to P9)	-	Direct acting indicating analogue electrical measuring instruments & their accessories.

Disconnecting switches

IEC-60129	-	Alternating Current Disconnectors (Isolators) and Earthing switches
IEC-1129	-	Alternating Current Earthing Switches Induced Current switching
IEC-60265 (Part 1 & Part 2)	-	High Voltage switches
ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment

Protection and control equipment

IEC-60051 : (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to part 23)	-	Electrical relays.
IEC-60297(P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.

- Expression of the performance of electrical & electronic measuring equipment.
- Symbols for Alternating-Current Electricity meters.
- Man machine interface (MMI) - Actuating principles.
- Class 0.5, 1 and 2 alternating current watt hour metres
- Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)

ANSI-81	-	Screw threads
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	-	Requirements for electrical analog indicating instruments

MOTORS

IS-325 -		Three phase induction motors.
IS-4691	-	Degree of protection provided by enclosure for rotating electrical machinery.
IEC-60034 (P1 to P19:)	-	Rotating electrical machines
IEC-Document 2	-	Three phase induction motors
(Central Office) NEMA-MGI		Motors and GeneratorsElectronic equipment and components
MIL-21B, MIL-833 & MIL-2750		
IEC-60068 (P1 to P5)		Environmental testing
IEC-60326 (P1 to P2):		Printed boardsMaterial and workmanship standards
IS-1363 (P1 to P3)		Hexagon head bolts, screws and nuts of product grade C.
IS-1364 (P1 to P5)	-	Hexagon head bolts, screws and nuts of products grades A and B.
-		Hexagonal Bolts and Nuts (M42 to M150)
-		Fasteners: Bolts, screws and studs
-		Specification and tests for materials

Clamps & connectors

IS-5561	-	Electric power connectors.
N EMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminum- Copper Overhead Conductors

Bus hardware and insulators

IS: 2121	-	Fittings for Aluminum and steel cored Al conductors for overhead power lines.
IS-731	-	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V.
IS-2486 (P1 to P4)		Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V.
IEC-60120		Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137		Insulated bushings for alternating voltages above 1000 V
IEC-60168		Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-60233		Tests on Hollow Insulators for use in electrical equipment. Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-60273		Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems
IEC-60305		Characteristics of String Insulator Units of the cap and pin type.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units : dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.

	- Characteristics of string insulator units of the long rod type.
	- Dimensions of Clevis and tongue couplings ofstringinsulator units.
	- Wet process porcelain insulators
	- Test methods for electrical power insulators
	- For insulators, wet-process porcelain and toughened glass suspension type
	- For wet-process porcelaininsulators apparatus, post-type
ANSI-G.8	- Iron and steel hardware
CISPR-7B	- Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	- Zinc Coating (Hot-Dip) on iron and steel hardware
	Dimensions & tolerances for Wrought Aluminum and Aluminum Alloys drawn round tube.
	Wrought Aluminum and Aluminum Alloy Bars.Rods, Tubes and Sections for Electrical purposes.
	Aluminum 1350 H19 Wire for electrical purposes
	Concentric - lay - stranded, aluminum 1350 conductors
	Aluminum - Alloy extruded bar, road, wire, shape
	Aluminum bars for electrical purpose (Bus-bars)
	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)

Batteries and batteries charger Battery

IS: 1651Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)

IS: 1652	- Stationary Cells and Batteries, Lead-Acid Type (with Plate Positive Plates)
IS: 1146	- Rubber and Plastic Containers for Lead-Acid Storage Batteries
IS:6071	- Synthetic Separators for Lead-Acid Batteries
IS:266	- Specification for Sulphuric Acid
IS:1069	- Specification for Water for Storage Batteries
IS:3116	- Specification for Sealing Compound for Lead-Acid Batteries
IS: 1248	- Indicating Instruments

Battery Charger

IS: 3895	- Mono-crystalline Semiconductor Rectifier Cells and Stacks
	- Mono-crystallineSemiconductorRectifier Assemblies and Equipment.
	- Safety Code for Semiconductor Rectifier Equipment
	- Power Transformers
	- AC Contactors for Voltages not Exceeding 1000 Volts
IS: 1248	- Indicating Instruments
IS:3231	- Electrical relays for power system protection
IS: 3842	- Electrical relay for AC Systems

IS:5 - Colours for ready mix paint

recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
Sizing large lead storage batteries for generating stations and substations
Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
PVC insulated cables for working voltages upto and including 1100 Volts.
Code of practice for installation and maintenance of power cables, upto and including 33 kV rating
PVC insulated (heavy duty) electric cables (part 1) for working voltage upto and including 1100 V.
Part (2) for working voltage from 3.3 kV upto and including 11kV.
Aluminium conductor for insulated cables Copper Conductor in insulated cables.

IS-3961 (P1 to P5) - Recommended current ratings for cables.
IS-3975 - Mild steel wires, formed wires and tapes for armouring of cables.
IS-5831 - PVC insulating and sheath of electric cables.
IS-6380 -Elastometric insulating and sheath of electriccables.
IS-7098 - Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100 volts.
IS-7098 - Cross-linked polyethyle insulated PVC sheathed cables for working voltage from 3.3kV upto and including 33 kV.
IS-8130 - Conductors for insulated electrical cables and flexible cords.
IS-1753 - Aluminum Conductors for insulated cables.
IS-10418 - Specification for drums for electric cables.
IEC-60096 (part 0 to p4) - Radio Frequency cables.
IEC-60183 - Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7) - Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7) Polyvinyl Chloride insulated cables of rated voltages up to and including 4501750V.
IEC-60228 - Conductors of insulated cables
IEC-60230 - Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3) - Calculation of the continuous current rating of cables (100% load factor).
IEC-60304 - Standard colours for insulation for low-frequency cables and wires.
IEC-6033 1 - Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3) - Tests on electric cables under fire conditions.
IEC-60502 - Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2) -Tests on gases evolved during combustion of electric cables.

AIR conditioning and ventilation

IS-659 - Safety code for air conditioning

IS-660	- Safety code for Mechanical Refrigeration
ARI: 520	-Standard for PositiveDisplacement Refrigeration Compressor and Condensing Units
IS:4503	- Shell and tube type heat exchanger
ASHRAE-24	- Method of testing for rating of liquid coolers
ANSI-B-31.5	- Refrigeration Piping
IS: 2062	- Steel for general structural purposes
IS:655	- Specification for Metal Air Dust
IS:277	- Specification for Galvanised Steel Sheets
IS-737	- Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS- 1079	- Hot rolled cast steel sheet & strip
IS-3588	- Specification for Electrical Axial Flow Fans
IS-2312	- Propeller Type AC Ventilation Fans
BS-848	- Methods of Performance Test for Fans
BS-6540 Part-I	- Air Filters used in Air Conditioning and General Ventilation
BS-3928	- Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	- Method of cold DOP & hot DOP test
MIL-STD-282	- DOP smoke penetration method

- Air cleaning device used in general ventilation for removing particle matter
- Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials.
- Expanded Polystyrene for Thermal Insulation Purposes

IS:8183	- Bonded Mineral Wool
IS: 3346	- Evaluation of Thermal Conductivity properties by means of guarded hot plate method
ASTM-C-591-69	- Standard specification for rigid preformed cellular urethane thermal insulation
IS:4894	- Centrifugal Fans
BS:848	- Method of Performance Test for Centrifugal Fans
IS:325	- Induction motors, three-phase
IS:4722	- Rotating electrical machines
IS:1231	- Three phase foot mounted Induction motors, dimensions of IS: 2233 Designations of types of construction and mounting arrangements of rotating electrical machines
ASTM-A-121-77	- Zinc-coated (Galvanized) steel barbed wire

Painting

IS-6005	- Code of practice for phosphating of iron andsteel.
ANSI-Z551	- Gray finishes for industrial apparatus andequipment

SSPEC - Steel structure paintingcouncil
Fire protection system
Fire protection manual issued by tariff advisory committee (TAC) of India

IS:9137 -Code for acceptance test for centrifugal &axial pumps
IS:5120 - Technical requirement – Roto dynamic special purpose pumps
API-6 10 - Centrifugal pumps for general services
- Hydraulic Institutes Standards
BS:599 - Methods of testing pumps
PTC-8. 2 - Power Test Codes - Centrifugal pumps

DIESEL ENGINES

IS: 10000 - Methods of tests for internal combustionengines
IS: 10002 - Specification for performance requirements for constant speed compression ignition engines for general purposes (above 20 kW)
BS: 55 14 - The performance of reciprocating compression ignition (Diesel) engines, utilising liquid fuel only, for general purposes
ISO:3046 - Reciprocating internal combustion engines performance
IS:554 - Dimensions for pipe threads where pressure tight joints are required on threads
ASME Power Test Code - Internal combustion engine PTC-17
- Codes of DieselEngine Manufacturer's Association, USA

PIPING VALVES & SPECIALITIES

IS:636 - Non percolating flexible fire fighting delivehose
IS:638 - Sheet rubber jointing and rubber insertingjointing
IS:778 - Gun metal gate, globe and check valves forgeneral purpose
IS:780 - Sluice valves for water works purposes (50 to300 mm)
IS: 90 1 - Couplings, double male and double female Instantaneous pattern for fire fighting
IS:902 Suction hose couplings for firefightingpurposes

- Fire hose delivery couplings branch pipe nozzles and nozzle spanner
- Cast iron fittings for pressure pipes for water, gas and sewage
- Ball valve (horizontal plunger type) including floats for water supply purposes
- SP for weldable structural steel

IS:2379 - Colour Code for the identification of pipelines
- Dimensions of pipe threads for fastening purposes
- Code of Practice for selection, installation and maintenance of sluice valves
- Sluice valves for water-works purposes (350 to 1200 mm size)
- Basket strainers for fire fighting purposes(cylindrical type)

- Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
- Foot valves for water works purposes
- Unlined flax canvas hose for fire fighting
- Landing valves (internal hydrant)
- Swing check type reflex (non-return) valves

(Part-I)

IS:5306	-	Code of practice for fire extinguishing installations and equipment on premises
Part-I	-	Hydrant systems, hose reels and foam inlets
Part-II	-	Sprinkler systems
BS:5 150	-	Specification for cast iron gate valves

MOTORS & ANNUNCIATION PANELS

IS:325	-	Three phase induction motors
IS:900	-	Code of practice for installation and maintenance of induction motors
IS:996	-	Single phase small AC and universal electric motors
	-	Dimensions of three phase foot mounted induction motors
	-	Flame proof enclosure of electrical apparatus
	-	Dimensions of flange mounted AC induction motors
	-	Designations for types of construction and mounting arrangements of rotating electrical machines
	-	Dimensions of vertical shaft motors for pumps
	-	Code of practice for climate proofing of electrical equipment
	-	Guide for testing three phase induction motors
	-	Degree of protection provided by enclosure for rotating electrical machinery
	-	Rotating electrical machines
IS:4729	-	Measurement and evaluation of vibration of rotating electrical machines
IS: 5572 (Part-I)	-	Classification of hazardous areas for electrical installations (Areas having gases and vapours)
IS: 6362	-	Designation of methods of cooling for rotating electrical machines
IS:6381	-	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	-	Guide for testinginsulation for rotatingmachine
IS:4064	-	Air break switches
IEC DOCUMENT 2	-	Three Phase Induction Motor (Control Office) 432
VDE 0530 Part I166	-	Three Phase Induction Motor

IS:9224 (Part-II) - HRC Fuses
IS: 6875 - Push Button and Control Switches
IS:694 - PVC Insulated cables
IS: 1248 - Indicating instruments

IS:375 - Auxiliary wiring & busbar markings
IS:2147 - Degree of protection
IS:5 - Colour Relay and timers
IS: 2959PG Test Procedures
NFPA-13-Standard for the installation of sprinklersystem
- Standard for water spray fixed system for the fire protection
- Standard for Halong 1301 Fire Extinguishing System
- Standard on Antomatic Fire Detectors

Fire Protection Manual by TAC (Latest Edition)
NFPA-12 -Standard on Carbon dioxide extinguishersystems
IS: 3034 - Fire of industrial building:
Electrical generating and distributing stations code of practice
IS:2878 - CO2 (Carbon dioxide) Type Extinguisher
IS:2171 DC (Dry Chemical Powder) type
Pressurised Water Type
Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes
Method of tests for internal combustion engines
Rotating electrical machines-specification Degree of protection provided by enclosures
Permissible limit of noise levels for rotating electrical machines.
Indian Explosive Act 1932
Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.
15-1363 (P1 to P3) -Hexagonal head bolts, screws & nuts ofproducts grade C.
15-1364 -Hexagon headbolts, screws and nuts ofproduct grades A and B.
15-1367 (P1 to P18) -Technical supply condition for threaded steel fasteners.
15-1599 - Methods for bend test.
I5- 1608 - Method for tensile testing of steel products.
I5- 1893 - Criteria for earthquake resistant design of structures.
15-1978 - Line Pipe.
15-2062 - 5teel for general structural purposes.
15-2595 - Code of practice for Radiographic testing.
15-3063 -Single coil rectangular section spring washers for bolts, nuts and screws.
15-3664 -Code of practice for ultrasonic pulse echo testing by contact and immersion methods.
IS-7205 -Safety code for erection of structural steelwork.

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

		silicon steel plates for machine parts and general construction.
ASTM-A234 allo y	-	Pipe fittings of wrought carbon steel and steel for moderate and elevated temperatures
ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105 components	-	Forgings, carbon steel for piping
ASTM-A307 standard	-	Carbon steel externally threaded fasteners
ASTM-A193 materials	-	Alloy steel and stainless steel bolting for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-Cast iron pipe flangesand glanged fitting. Class 25, 125, 250 and 800	
ANSI-B16.1 and	-	Malleable iron threaded fittings, class 150 300
ANSI-B16.5 nickel	-	Pipe flanges and flanged fittings, steel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14 with	-	Ferrous pipe plug, bushings and locknuts pipe threads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1 andscrews	-Inch series square and hexagonal bolts	
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe
Other civil works standards		
IS-269	-	33 grade ordinary portland cement.
IS2721	-	Galvanized steel chain link fence fabric

IS-278 - Galvanized steel barbed wire for fencing.
IS-383 - Coarse and fine aggregates from natural sources for concrete
Mild steel and medium tensile steel bars and hard-dawn steel wire for concrete reinforcement.
Code of practice for plain and reinforcedconcrete.
Method of test for strength of concrete.
Code of practice for general construction in steel.
Steel tubes for structural purposes.
Basic requirements for water supply, drainage and sanitation.
Methods of sampling and analysis of concrete.
Hard-dawn steel wire fabric for concrete reinforcement.
Code of Practice for Building drainage.
Plain hard-drawn steel wire for pre stressed concrete.
standard Galvanized steel wire for fencing.
1S-2470 (P1 & P2) - Code of practice for installation of septic tanks.

1S-2514 - Concrete vibrating tables.
1S-2645 - Integral cement waterproofing compounds.
Methods of sampling and test (Physical and chemical) for water and waste water.
Code of practice for design and construction of foundations for transmission line towers and poles.

1S-4111(Part 1 to P5) - Code of practice for ancillary structures in sewerage system.
15-4990 - Plywood for concrete shuttering work.
15-5600 - 5ewage and drainage pumps.
National building code of India 1970
U5BRE12 - Earth Manual by United 5tates Department of the interior Bureau of Reclamation
A5TM-A392-81 - Zinc1Coated steel chain link fence fabric
A5TM-D1557-80 - test for moisture-density relation of soils using
10-lb (4.5 kg) rame land 18-in. (457 mm) Drop.
A5TM-D1586 - Penetration Test and 5plit-Barrel
(1967) - Sampling of Soils

CPWD - Latest CPWD specifications
ACSR MOOSE CONDUCTOR
IS:6745 Methods for Determination of Mass of zinc coating on zinc coated Iron and Steel Articles BS:443-1969

IS:8263 Methods for Radio Interference
IEC:437-1973 Test onHighVoltageInsulators
NEMA: 107-1964
CISPR
IS:209 Zinc Ingot BS:3436-1961
IS:398 Aluminum Conductors for IEC:209-1966

Part - V	Overhead Transmission Purposes	
BS:215(Part-II)	Aluminium Conductors galvanized steel reinforced extra high voltage (400 kV and above)	IEC:209-1966
BS:215(Part-II)		
IS:1778	Reels and Drums for Bare Conductors	BS:1559-1949
IS: 1521	Method for Tensile Testing of steel wire	ISO1R89-1959
IS:2629	Recommended practice for Hot dip Galvanising on Iron and Steel.	
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles.	
IS:4826	Hot dip galvanised coatings on round steel wires	

GALVANISED STEEL EARTH WIRE

IS: 1521	Method for Tensile Testing of Steel Wire	ISO1R:89-1959
IS: 1778	Reels and Drums for Bare Conductors	
IS:2629	Recommended practice for Hot Dip Galvanising on Iron and Steel.	
IS:2633	Methods for testing Uniformity of Coating of Zinc Coated Articles.	
IS:4826	Hot dip Galvanised Coatings on Round Steel Wires	ASTM:A 475-72a BS:443-1969
IS:6745	Method for Determination of mass of Zinc Coating on Zinc coated Iron and Steel Articles.	BS:443-1969
IS:209	Zinc ingot	BS:3463-1961
IS:398 (Pt. Ito P5:1992)	Aluminum Conductors for overhead transmission purposes.	BS:215 (Part-II)

Lighting Fixtures and Accessories

(i) IS: 1913	General and safety requirements for electric lighting fittings.	
(ii) IS:3528	Water proof electric lighting fittings.	
(iii) IS:4012	Dust proof electric lighting fittings.	
(iv) IS:4013	Dust tight proof electric lighting fittings.	
(v) IS: 10322	Industrial lighting fittings with metal reflectors.	
(vi) IS:10322	Industrial lighting fittings with plastic reflectors.	
(vii) IS:2206	Well glass lighting fittings for use under ground in mines (non-flameproof type).	
(viii) IS: 10322	Specification for flood light.	
(ix) IS:10322	Specification for decorative lighting outfits.	
(x) IS: 10322	Luminaries for street lighting	
(xi) IS:2418	Tubular fluorescent lamps	
(xii) IS:9900	High pressure mercury vapour lamps.	

(xiii) IS: 1258 Specification for Bayonet lamp flourescent lamp.
(xiv) IS:3323 Bi-pin lamp holder tubular fluorescent lamps.
(xv) IS:1534 Ballasts for use in fluorescent lighting fittings. (Part-I)
(xvi) IS:1569 Capacitors for use in fluorescent lighting fittings.
(xvii)IS:2215 Starters for florescent lamps.
(xviii)IS:3324 Holders for starters for tubular fluorescent lamps
(xix) IS:418 GLS lamps
(xx) IS:3553 Water tight electric fittings
(xxi) IS:2713 Tubular steel poles
(xxii)IS:280 MS wire for general engg. Purposes

Conduits, Accessories and Junction Boxes

(1) IS:9537 Rigid steel conduits for electrical wiring
(2) IS:3480 Flexible steel conduits for electrical wiring
(3) IS:2667 Fittings for rigid steel conduits for electrical wiring
(4) IS:3837 Accessories for rigid steel conduits for electrical wiring
(5) IS:4649 A daptors for flexible steel conduits.
(6) IS:5 133Steel and Cast Iron Boxes
(7) IS:2629 Hot dip galvanising of Iron & Steel.

Lighting Panels

(1) IS: 13947 LV Switchgear and Control gear(Part 1 to 5)
(2) IS:8828 Circuit breakers for over current protection for house hold and similar installations.
(3) IS:5 Ready mix paints
(4) IS:2551 Danger notice plates
(5) IS:2705 Current transformers
(6) IS:9224 HRC Cartridge fuse links for voltage above 650V(Part-2)
(7) IS:5082 Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes.
(8) IS:8623 Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC.
(9)IS: 1248 Direct Acting electrical indicating instruments

Electrical Installation

(1) IS: 1293 3 pin plug
(2) IS:371 Two to three ceiling roses
(3) IS:3854 Switches for domestic and similar purposes
(4) IS:5216 Guide for safety procedures and practices in electrical work.
(5) IS:732 Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
(6) IS:3043 Code of practice for earthing.
(7) IS:3646 Code of practice of interior illumination part II & III.
(8) IS: 1944 Code of practice for lighting of public through fares.
(9) IS:5571 Guide for selection of electrical equipment for

	hazardous areas.
(10) IS:800	Code of practice for use of structural steel in general building construction.
(11) IS:2633	Methods of Testing uniformity of coating on zinc coated articles.
(12) IS:6005	Code of practice for phosphating iron and steel.
(13)	INDIAN ELECTRICITY ACT
(14)	INDIAN ELECTRICITY

RULES LT SWITCHGEAR

IS:8623 (Part-I)	Specification for low voltage switchgear and control gear assemblies
IS: 13947 (Part-I)	Specification for low voltage switchgear and control gear, Part 1 General Rules
IS: 13947 (part-2)	Specification for low voltage switchgear and control gear, Part 2 circuit breakers.
IS: 13947 (part-3)	Specification for low voltage switchgear and control gear.
	Part 3 Switches, Disconnectors, Switch-d isconnectors and fuse combination units
IS: 13947 (part-4)	Specification for low voltage switchgear and control gear.
	Part 4 Contactors and motors starters.
IS: 13947 (part-5)	Specification for low voltage switchgear and control gear.

Part 5 Control-circuit devices and switching elements

IS: 13947 (part-6)	Specification for low voltage switchgear and control gear.
	Part 6 Multiple function switching devices.
IS: 13947 (part-7)	Specification for low voltage switchgear and control gear.
	Part 7 Ancillary equipments
IS: 12063	Degree of protection provided by enclosures
IS:2705	Current Transformers
IS:3 156	Voltage Transformers
IS:323 1	Electrical relays for power system protection
IS: 1248	Electrical indicating instruments
IS:722	AC Electricity meters
IS:5578	Guide for Marking of insulated conductors of apparatus terminals
IS: 13703 (part 1)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 1 General Requirements
IS: 13703 (part 2)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 2 Fuses for use of authorized persons
IS:6005	Code of practice of phosphating iron and steel
IS:5082	Wrought Aluminum and Aluminum alloys for electrical purposes
IS:2633	Hot dip galvanising
IS: 15959	for data exchange of energy meter

& latest amendment

TECHNICAL SPECIFICATIONS – CIVIL WORKS

1.0 GENERAL

1.1. The intent of this technical specification covers the following:

1.1.1. Construction of all civil works at sub-station is covered in the scope of contract. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/Code and Technical Specification, the provisions of Technical Specifications shall prevail.

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

1.1.3. All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the Contractor. All testing of construction material required shall be arranged by the Contractor at his own cost. All the construction material shall have to be got approved prior to use, from Engineer-in-charge of CSPTCL.

1.1.4. The bidder shall fully appraise himself of the prevailing conditions at the proposed site. Climatic conditions including monsoon patterns, local conditions and site specific parameters, availability of all construction materials as per specifications and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications/Bill Of Quantity.

2.0 DRAWINGS

2.1. The Contractor shall execute the work at site as per approved drawings only. Photocopies shall not be used at site. The drawing for all the works shall be developed by the contractor and submitted to CSPTCL for approval in 02 copies along with design calculation, which will be scrutinized and corrected. After incorporating corrections indicated in corrected drawings, 05 prints shall be submitted by contractor for issuing as approved drawings, which only shall be used at site for carryout construction. The scrutiny /approval of drawings by CSPTCL does not absolve the contractor in any manner from owning complete responsibility towards safety and security of all the civil structures designed and constructed by them. Safety, security and adequacy of all civil structures from design, construction and erection point of view lies entirely with the contractor even after approval of drawings by CSPTCL. The drawings required to be submitted shall be for following works in general :-

2.1.1. Control Room building
2.1.2. Fire fighting pump house building and fire water tank
2.1.3. Foundations for Tower, equipment, loading /unloading gantry etc.
2.1.4. Contour drawings, lay out drawings, cable trench crossings, roads, culverts, fire resistant wall, cable trenches, burnt oil pit, trench covers etc.
2.1.5. Roads and rail cum Road
2.1.6. Drains
2.1.7. Welded Mesh fencing and gate
2.1.8. Drainage system
2.1.9. Water supply arrangement
2.1.10. Septic tank and soak pit
2.1.11. Camping house
2.1.12. Stone spreading and antiweed treatment

2.1.13. Any other drawing for works not mentioned above but required for execution of work shall also be submitted and got approved by contractor.

3.0 SITE PREPARATION AND EARTHWORK

3.1. SCOPE

3.1.1. This clause covers the execution of the work for site preparation, such as clearing of the site, the supply and compaction of fill material, excavation and compaction of backfill for foundation, road construction, drainage, trenches, etc.

3.2. SITE CLEARING & LEVELLING

3.2.1. Material unsuitable for laying of foundations shall be removed and replaced by suitable fill material as per approval of CSPTCL.

3.2.2. Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by CSPTCL.

3.2.3. Site clearing, levelling: - Before the work is commenced, the area described and shown on plan shall be cleared by the contractor at his own cost, of all obstructions, including abandoned brick masonry/concrete/steel structures, loose stones, materials, vegetation such as grass, shrubs, bushes and stumps of trees, roots etc. as directed. The product of the clearing shall be stacked in such places and in such manner as instructed by the Engineer-in-charge of CSPTCL and the ground left in a perfectly clean condition. The useless materials obtained by the clearing should be removed from the area and disposed off as directed by the Engineer-in-charge of CSPTCL for which no payment will be made by CSPTCL. All holes or hollows whether originally existing or produced by digging and up roots shall be carefully filled up with earth well rammed and levelled off as directed. On completion of the works, the site around the building structures shall be cleared by the contractor at his own expense to the satisfaction of the Engineer-in-charge of CSPTCL.

3.2.4. The excavated material shall be the property of CSPTCL & its storage, use or disposal, shall be done as directed by the Engineer in charge of CSPTCL

3.2.5. The contractor shall level the entire area up to desired level through cutting/filling. The excavated material if found suitable may be used by the contractor for levelling. However royalty/taxes as decided by concerned Govt. / CSPTCL authority on such use shall be borne by the contractor. In case hard rock is obtained in excavation then such material shall be taken in MAS of CSPTCL for proper record.

3.3. EXCAVATION AND BACKFILL

3.3.1. Excavation and backfill for foundations shall be in accordance with the relevant code.

3.3.2. If excavated soil in foundations is non-expansive, then same shall be used for backfilling. If, excavated soil is expansive, then the foundation shall be backfilled by non-expansive soil. In either case no separate payment shall be made.

3.3.3. No separate payment shall be made for any type of soil/rock encountered during excavation of foundations as per approved LUP/drawings.

3.3.4. Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling for which no extra payment shall be made by CSPTCL.

3.3.5. When embankments are to be constructed on slopes of 15° or greater, horizontal benches or steps with horizontal and vertical faces shall be cut in the

original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.

3.3.6. Embankments adjacent to abutments, culverts, retaining walls & similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness (of loose material before compaction). Each layer shall be compacted at OMC as required by means of mechanical tampers plate vibrator/rollers approved by the Engineer-in-charge of CSPTCL following procedure outlined under compaction. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.

3.3.7. Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted at OMC to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

3.3.8. The soil from excavation of foundation, cable trenches etc. if used for yard levelling (with proper compaction at OMC using vibratory plate compactor) as per direction of Engineer-in-Charge, no extra payment shall be admissible. The soil so used shall be adjusted in the quantity for levelling. If the excavated material is not usable, then same shall be disposed off as per direction of Engineer-in-charge for which no extra payment shall be made.

3.4. COMPACTION

3.4.1. The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of engineer-in-charge. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 90% of Maximum Dry Density. The sub grade for the roads and embankment filling shall be compacted to minimum 90% of Maximum Dry Density.

3.4.2. At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

3.4.3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out during rain.

3.4.4. Drainage arrangement like '*Katcha Drain'* should be made around periphery of substation yard so that storm water does not enter / foul construction area / substation yard.

3.5. REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION

3.5.1. The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the CSPTCL.

4.0 ANTIWEED TREATMENT & STONE SPREADING

4.1. SCOPE OF WORK

4.1.1. The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the approved drawings, specification and direction of the CSPTCL. Stone spreading along with stone dust/sand layer shall be done in the areas of the switchyard under present scope of work. However the stone spreading along with underlying layer in future areas within fenced area shall also be provided in case step potential without stone layer is not well within safe limits.

4.2. METAL SPREADING

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

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

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

Sieve Size	% passing by weight
63mm	100
40mm	85-1 00
20mm	0-20
10mm	0-5

"One Test" shall be conducted for every 500 cu.m.

(b) Hardness
   (i) Abrasion value (IS: 2386 Part-IV) – not more than 40%
   (ii) Impact value (IS: 2386 Part-IV) – not more than 30% and frequency shall be one test per 500 cu.m. with a minimum of one test per source.

(c) Flakiness Index
   (iii) One test shall be conducted per 500 cu.m. of aggregate as per IS: 2386 Part – I and maximum value is 25%.

4.2.3. After all the structures/equipments are erected, antiweed treatment shall be applied in the switchyard where ever stone spreading along with underlying layers is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used. The antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10MX10M (approx) and shall be sprinkled with water at least once in the afternoon everyday after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – in- charge. The final approval shall be given by Engineer – in –charge based on the results.

4.2.4. Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

4.2.5. After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in charge. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

4.2.6. In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.

4.2.7. Over the prepared sub grade, first 100 mm thick layer of moorum shall be laid and in case of BC soil the layer thickness shall be 200 mm, over which 100 mm thick layer of stone dust shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of top layer of stone dust.

4.2.8. A final layer of 100mm thickness of crusher broken hard metal of 40 mm nominal size (ungraded size) shall be spread uniformly over underlying layer of stone dust/sand.

S. No.	Particulars	% age voids to be deducted
1.	Metal	8 %
2.	Moorum/Sand	16 %
3.	Stone dust	25%

5.0 RAINWATER HARVESTING:

5.1. It shall be total responsibility of contractor to provide drainage system of entire yard as per direction of Engineer in charge of CSPTCL. No extra payment shall be made on this account.

5.2. In addition to drainage of rainwater, the contractor shall make arrangement for rainwater harvesting also.

5.3. Rainwater harvesting shall be done by providing two numbers recharge structures with bore wells. The recharge structures shall be suitably located within the substation. Branch drains from the main drain and cable trenches carrying rainwater from entire switchyard shall be connected to the recharge structures by RCC drain/Hume Pipes. For RCC drains, suitable RCC cable trench section without MS angle shall be used. No extra payment shall be made for these RCC drain/Hume Pipes. Overflow arrangement shall be provided for each pit and the overflow shall be taken through trench/closed conduit (Np3 pipe) of approved size/Diameter up to nearest available natural drainage at such a level to completely ensure effective drainage in all seasons. No extra payment shall be made on this account. It shall be total responsibility of contractor to decide and design yard level and drainage system such that to ensure complete and effective drainage of entire s/s area in all seasons with drainage of water from entire s/s area up to nearest available natural drainage as per direction of Engineer in charge of CSPTCL.

5.4. The internal diameter of recharge shafts shall be 4.5 meter. The overall depth of shaft shall be 5.0 meter below invert level of drain. The shaft shall be of RCC

with thickness as per design requirement and approved drawing. The shaft shall be covered with RCC slab for a live load of 300 kg. per sqm. Two openings of size 0.7 x 0.7 meter shall be provided in the RCC cover slab as per approved drawing. An iron cover made of 6mm thick chequered plate with hinges shall be provided on the openings. Galvanized Steel rungs of 20 mm diameter at spacing of 300 mm and min 200 mm projecting outside wall face shall be provided in the wall of shaft below the opening in the RCC slab to facilitate cleaning of shaft.

5.5. A 300 mm diameter bore well shall be drilled in the centre of the shaft. The depth
of bore well shall be 15.0 meter more than the depth of sub soil water or bottom of shaft whichever is deeper.

5.6. A 100 mm Diameter medium duty MS pipe conforming to IS 1161 shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58 mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0 mm Diameter shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and down wards. The overall length of pipe shall be equal to total depth of bore well plus depth of shaft.

5.7. Gravel of size 3 mm to 6 mm shall be filled around 100 Diameter MS pipe in the bore well. The shaft shall be filled with 500 mm thick layers each from the bottom of shaft with boulders of size 50 mm to 150 mm, gravel of size 5 mm to 10 mm, coarse sand having particle size 1.5 mm to 2.0 mm and boulders of size not less than 200 mm respectively.

6.0 ROADS AND CULVERTS

6.1. All the roads in the scope of contract shall be of concrete road.

6.2. There would be three types of Roads. The road for diversion of existing road shall be 3.75 m wide WMM while S/S roads (on inside of S/S as well as outside approach road up to s/s) shall be 5.5 m wide and 3.75m wide RCC road. In view of the type of the soil of the substation land which is black cotton soil, RCC side drains shall also be provided on both sides of all the roads, of section and at gradient required as per site condition to drain out all the water falling in entire s/s area, with necessary culvert crossings using NP3 pipes/RCC slab culvert with stone/Brick masonry wing wall as per approved drawings. In case of all the roads, the shoulder would be compacted hard moorum 750 mm wide on both the sides.

6.3. Layout of the roads shall be as per approved LUP drawing for the substation. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the Autotransformer shall be as short and straight as possible.

6.4. The substation roads shall have 150 mm thick RCC (1:1.5:3 nominal mix with reinforcement of 8mm Diameter. 200 C/C both ways) on the top. Below it 100mm thick PCC (1:3:6) shall be provided. 160 mm thick water mix macadam (WMM) in two equal layers shall be laid below PCC over 200 mm thick well compacted layer of oversize metal and stone dust/moorum (soling). It may please be noted that the metal to be used in roadwork shall be either Black Trap, basalt or Granite only. Availability of these metals at site may be ensured by Bidder prior to quoting rates.

6.5. For diversion of existing road the road section shall be as follows:-

(a) 150 mm thick RCC layer of M 20 grade concrete with 8 mm Diameter TMT bars at 200 mm c/c both ways at top.

(b) 100 mm thick layer of PCC (1:3:6) below RCC.

(c) 160 mm thick WBM in two equal layers below PCC.
(d) 200 mm oversize metal and stone dust/moorum layer (soling) well compacted below WMM at bottom.

6.6. PCC and WMM shall be placed only up to the width of the road. Polythene sheet of 125 microns shall be placed between the RCC and PCC slab. Expansion joint (min. 12 mm thick) shall be provided at every 8.0 m with dowel bars as per relevant applicable IS code. In addition, in case of 5.5 m wide road, expansion joint shall also be provided longitudinally at the centre. 100 mm diameter RCC Hume pipe (NP-3) shall be provided at every 100 m interval across the length of the road and at every intersection points of road / where direction changes / as per direction of Engineer-in-Charge for cable crossing.

6.7. Adequate turning radius, tracking off / extra widening / swept path shall be provided for trailer at all turnings of roads. No extra payment shall be made on this account.

7.0 FOUNDATION /RCC CONSTRUCTION

7.1. GENERAL

7.1.1. Work covered under this Clause of the Specification comprises the construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Autotransformer, marshalling Bay Rooms, auxiliary equipments &systems buildings, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

7.1.2. Concrete shall conform to the requirements mentioned in latest IS:456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification a minimum grade of M20 concrete (1: 1.5: 3 mix) shall be used for all construction works unless specified otherwise. It may please be noted that the metal to be used for R.C.C. works shall be either Black Trap, basalt or Granite only. Availability of these metals at site may be ensured by Bidder prior to quoting rates.

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

7.1.3.1. The switchyard foundation’s top shall be minimum 300 mm above finish yard level.

7.1.3.2. The building plinths shall be minimum 600 mm above road top level / yard level whichever is higher.

7.1.4. Minimum 100 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

7.1.5. Only OPC or PPC 53 grade of approved and reputed brand shall be used in construction works and test certificate from manufacturer shall have to be submitted to engineer in charge of CSPTCL for kind of cement being used.

7.1.6. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided. For determining soil characteristics detailed soil investigation of entire s/s area shall be got done by the contractor from a reputed firm including plate load test and bore holes upto 6.0 m depth spread all over the yard. The soil investigation report shall be got approved from CSPTCL authorities and as

per approved parameters only foundation shall be got designed by the contractor.

7.1.7. In case of compressible clay/highly compressible clay/expansive soil, pile foundations are adopted, the same shall be cast-in-situ bored or pre-cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. The Contractor at their cost to establish the piles design capacity shall carry out necessary initial load test. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the testing work shall be planned in such a way that these shall not cause any delay in project completion.

7.1.8. All foundations shall rest on firm natural non expansive soil / soil in stable zone.

7.1.9. If foundation other than pile is mediatory for design, 300 mm wide and 300 mm boulder moorum/stone dust soling shall be provided below foundation PCC and depth of foundation shall be minimum 3000 mm below natural ground level.

7.1.10. All the cable trenches shall be of RCC.

7.2. DESIGN

The following clauses shall be applicable, for which the contractor may have to design as mentioned at Clause 2.1.

7.2.1. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the CSPTCL.

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

7.2.3. For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. TMT bars only as per relevant IS codes shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS: 432 can also be used and test certificate from manufacturer shall have to be submitted to engineer in charge of CSPTCL for kind of steel being used.

7.2.4. Two layers of reinforcement (on inner and outer face) shall be provided for wall &slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per IS: 456 (latest).

7.2.5. RCC water retaining structures like storage tanks, etc. shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

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

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

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

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

7.2.10. Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

7.2.11. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including retaining wall ,channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

7.2.12. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

(a) Full water pressure from inside and no earth pressure &ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).

(b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

(c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

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

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

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

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

7.2.17. The tower and equipment foundations shall be designed and checked as per relevant IS code. The same factors shall be used as partial safety factor over loads in limit state design also.

7.3. ADMIXTURES & ADDITIVES

7.3.1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

7.3.2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Concrete Admixtures/Additives shall be approved by CSPTCL.

7.3.3. The Contractor may propose and the CSPTCL may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

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

7.3.5. The water proofing cement additives shall be used as required/advised by the CSPTCL.

8.0 CHAIN LINK FENCING AND GATE:

Fencing and gate shall be provided as per details given below:

8.1. AREAS REQUIRING FENCING

8.1.1. Fencing shall be provided for complete switchyard as per approved drawing leaving at least 6.0 m clear space after equipment. Separate gate shall be provided for men and equipment.

8.1.2. Internal fence surrounding the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.

8.2. FENCING MATERIALS & SPECIFICATIONS

8.2.1. The minimum requirements are as follows:

8.2.1.1. GI Chain link mesh (with galvanization) in accordance to IS: 2721.

a. Size of opening in mesh : 75mm x 75mm
b. Nominal wire size : 8 gauge
c. Height of chain link mesh : 2400 mm
d. Overall Height of Fencing : Min. 3000 from FYL
e. Tensile strength of line wire : 39 to 59 kg/sq. mm
f. Minimum breaking load of Complete barbed wire : 370 kg

On the results of these tests, the whole or portion of the chain link mesh / barbed wire shall be accepted or discarded by the CSPTCL authorities as the case may be.

8.2.1.2. Posts

(a) The posts shall be hot dip galvanized iron angle posts of size 65 x 65 x 6 at 2.5m c/c spacing with 45x45x5 angle galvanized iron bracings at top and bottom of mesh. The vertical posts shall have further V shaped extension of 400 mm (vertical height) over the chain link mesh top. Six rows of barbed wires with weight not less than 9.38 kg per 100 m shall be provided in the V shaped portion. Two Nos. GI wire of min 8 gauge shall be provided between top & bottom bracing angles along the entire length of mesh which shall be tightened to provide stiffness to mesh. Strainer posts shall be provided at every corner and at every 10th post. Strainer posts shall be provided on either side of vertical post and from inner side as well.

(b) Fencing top shall be provided with galvanized barbed wire. Barbed wire shall conform to IS: 278. The barbed wire may consist of not more than two splices per reel. The barbed wire shall be formed by twisting two line wires, one containing the barbs. The barbed wire shall be designed as Type A of IS: 278 and shall be galvanized.

(c) Barbed wire arms shall be same as intermediate and straining post.

(d) Fittings and hardware: cast aluminum alloy or galvanized steel, malleable or ductile cast iron turnbuckles to be drop forged.

(e) For every 50 reels or part there of samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to the tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

(f) The whole assembly of angles shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per sq. meter. The purity of zinc shall be 99.95% as per IS: 209.

8.2.1.3. Brick Wall below mesh

(a) Brick masonry wall of Min. 200 mm thickness shall be provided at bottom of mesh with plastering, 75 mm thick coping of PCC 1:2:4 grade, painting with exterior paint of reputed and approved brand etc. complete in all respects. The wall shall be min. 200 mm below natural ground level and 200 mm above FYL. PCC (1:3:6) of 100 mm thickness and 300 mm width shall be provided below wall in hard soil for depth of wall upto 400 mm. However if the overall depth of wall exceeds 400 mm, the thickness of wall and width of PCC shall be designed to bear the superimposed loads. In case of compressible / highly compressible / expansive soil in foundation, 200 mm thick brick wall shall be provided over RCC bracing beam of min size 200 x 200 mm supported on single reamed pile foundation of minimum 200 mm diameter depth 3500 mm below natural ground level. The height of wall shall be such that the top of wall shall be 200 mm above FYL.

8.3. GATE MATERIALS & SPECIFICATIONS

8.3.1. The gate shall be made of medium duty M.S. pipe conforming to relevant I.S. with welded joints. The main frame (outer frame) of the gate shall be made of 40mm Diameter pipe and vertical pipes of 15 mm Diameter @ 125 mm c/c spacing (maximum) shall be welded with the main frame. Other details shall be as per approved drawing.

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

8.3.3. The gates shall be provided with suitable locking arrangement.

8.3.4. The main gate shall be 6.0 m wide and shall be of double leaf type (as per approved drawing). Next to the main gate, a side gate (1.25m wide single leaf) shall also be provided.

8.3.5. Steel roller shall be provided with the gate.

8.3.6. Gate shall be installed as per approved G.A. drawing.

8.3.7. Alongside gate guard room shall be provided as per approved LUP.

8.3.8. The gate shall be provided on RCC columns of min. dimension 300 mm x 300 mm. with min. footing size 1000 x 1000 depth 200 and 300 at least 1500 mm below natural ground level but up to hard strata. The dimensions indicated are min to be provided and may be more as per site condition and design requirement.

9.0 WATER SUPPLY ARRANGEMENTS

9.1. FOR CONTROL ROOM BUILDING, CAMPING HOUSE & EARTH PITS

9.1.1. Two number 150 mm Diameter tube wells, each with minimum 1000 litre per hour yield, separate pump houses, two numbers overhead water tank of 1000 litre capacity above control room building, one numbers surface water tank of at least 20,000 litre capacity with bottom of tank min. 2000 mm above FYL at suitable location for supplying water to all the earth pit through gravity, complete water supply arrangements from both the bores to both the water tanks, from overhead water tank to Control Room Building and from both the

bores as well as from surface tank to all the earth pits, with submersible pumps, panels, cables, water tanks, GI pipe lines, all fittings, fixtures etc. of approved make as per specifications, in standard manner, as per direction of engineer in charge of CSPTCL. Both the bores shall be connected to water storage tank for fire fighting also. One number 150 mm diameter Borewell for camping house shall be provided. Each bathroom/toilet of camping house shall be provided with 1000 litre capacity overhead water tank and inter-connected. Separate one number 1000 litre capacity water tank provided for kitchen.

9.1.2. The supply network to all the earth pits shall be closed loop type ensuring supply from both the ends with designed sizes of pipes to ensure effective supply of water to all the earth pits. Schematic drawing shall be prepared by the contractor indicating the layout and details of each water supply scheme which shall be got approved before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.

9.2. FOR FIRE PROTECTION SYSTEM

9.2.1. One number 150 mm Diameter tube well, with minimum 5000 litre per hour yield, separate pump house, with submersible pump, panels, cables, water tanks, GI pipe lines, all fittings, fixtures etc. of approved make as per specifications, in standard manner, as per direction of engineer in charge of CSPTCL.

9.2.2. The entire Bore well shall be provided with 3-phase water cooled submersible pumps of KSB/Kirlosker make of minimum 3 H.P. or more as per requirement /directions of CSPTCL's engineer in charge with Crompton Greaves /Havells make control panels, Finolex/ Havells make cables.

9.2.3. Schematic drawing shall be prepared by the contractor indicating the layout and details of each water supply scheme which shall be got approved before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.

9.3. BORE WELL RECHARGE SYSTEM

9.3.1. The rain water from all buildings within the scope of work viz. control room building, camping house, bay marshalling rooms, store shades, etc. shall be collected at one or more outlet points of each building through rain water pipe of suitable size or as per drawing. At each outlet points rainwater harvesting filter such as 'Rainy Filter FL-200' suitable for roof area of buildings to be provided at outlet point and these outlet shall be connected to rainwater harvesting pit. Rain water harvesting pit are to be constructed as per approved drawing by CSPTCL around bore well for direct recharge of bore wells. No extra payment shall be made on this account.

10.0 TECHNICAL DETAILS OF THE BUILDINGS

10.1. AREA REQUIREMENT OF CONTROL ROOM BUILDING CUM ADMINISTRATIVE BUILDING:

10.1.1. Minimum carpet area requirements are given below:

a) GROUND FLOOR :- Measurements are in mm

i)	Store room	7000x5000
ii)	ACDB room	10000x15000
iii)	Battery Charger & DCDB	8000x6000
iv)	Battery room	8000x15000
v)	Electrical Testing lab	6000x10000
vi)	S/S in charge office	Office 5000x6000
	Plus attached toilet plus PS room	Toilet 2800x2500
		Steno 2800x3000

vii)	Room for engineers (Four Numbers)		4000x3000 each
viii)	Area for administrative office		10000x10000
ix)	Library		5000x4000
x)	Corridor		Min. width 2500
xi)	Portico		7500x5000
xii)	Common Toilet for Engineer's		2500x2800
xiii)	Pantry		3000x2700
xiv)	Conference hall		8000x6000
xv)	Toilet for administrative office	Gents	2500x2500
		Ladies	2500x2000
xvi)	Record room		4000x6000
xvii)	Stair case	Landing width min 1500	
		Tread 300 mm with nosing Riser 150 mm	

b) FIRST FLOOR :-

i)	1. Control Room		10000x5000
ii)	2. Room		5000x5000
iii)	3. Common toilet	Gents	2500 x 2000
		Ladies	2500x 2000

10.1.2. The complete building shall be designed as two storied building to cater for future expansion with live load as 400 kg per sq.m on ground floor roof on uncovered portion also.

10.1.3. The orientation of control room building shall be such to ensure maximum visibility of yard from control room hall. For this purpose the C/R hall shall have max. possible glazing towards yards sides.

10.1.4. Calcium silicate (water proof) boards false ceiling in good looking architectural patterns with borders, projections ,designs shall be provided in C/R hall, S/S in charge room and Conference room.

10.1.5. The min clear floor height of building i.e. height between finished floor top to soffit of slab shall be 3500 mm.

10.1.6. The Electrical Testing Lab, administrative office and library shall have sufficient numbers of built in Lockable Almirahs on the walls for housing Testing Equipments with sliding doors on Aluminium frames. Also the Administrative Building and the Library shall have Lockable Almirahs on any one wall with sliding doors on Aluminium frames.

10.1.7. Any future possibility of annex buildings shall be taken care of while finalizing the lay out of the control room building.

10.2. OTHER TECHNICAL DETAILS OF CONTROL ROOM, CAMPING HOUSE & OTHER BUILDINGS

10.2.1. 15 mm cement plaster of mix 1:6 (1 cement : 6 fine sand) shall be provided on the smooth side of internal walls.

10.2.2. 6 mm cement plaster of mix 1:3 (1 cement : 3 fine sand) to all ceiling.

10.2.3. 20 mm cement plaster of mix 1:6 (1 cement: 6 fine sand) on rough side of single or half brick wall.

10.2.4. 12 mm thick pre-laminated three layer medium density (exterior grade) particle board Grade I, Type II conforming to IS:12823 bonded with phenol formaldehyde synthetic resin, of approved brand and manufacture shall be provided in panelling fixed in aluminium doors, windows shutters and partition frames with C.P brass / stainless steel screws etc. complete as per approved architectural drawings and directions of engineer-in-charge.

10.2.5. All internal wall surfaces / ceiling of Control Room Building shall be applied Birla/J.K cement based water proof putty. Painting on all internal walls and

ceilings with **plastic emulsion paint** of Asian/ICI/Nerolac/Berger brand to give an even shade (two or more coats). Over plaster first apply cement primer then, putty over it paint primer & then painting is to be done.

10.2.6. Painting on all external walls two or more coats of **Ultima or Weather Coat or Weather Shield brand** paint over two under coats of **Plasto proof** make primer over new cement plaster surfaces of the C/R building inclusive of required tools, scaffolding, materials and other painting accessories etc. as per recommendations of manufacturer.

10.2.7. Enamel Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be provided on the steel glazed doors, windows, ventilators and rolling shutters in various buildings as per approved drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.

10.2.8. Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors.

10.2.9. ACDB room in Control Room building and FFPH building shall be provided 52 mm thick cement concrete flooring with "Hardcrete" concrete hardener topping under layer 40 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick metallic concrete hardener consisting of mix 1: 2 (1 cement hardener mix : 2 stone aggregate 6 mm nominal size) by volume with which "Hardcrete" hardening compound of "Snowcem India Ltd" or equivalent is mixed @ 2 litre "Hardcrete" per 50kg of cement including cement slurry, complete. (In ACDB Room and FFPH building only).

10.2.10. Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement: 3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of neat cement. 21 mm thick in ACDB room.

10.2.11. Floor tiles of Polished porcelain (vitrified) in different sizes with water absorption less than 1 % and flexural strength not less than 30 N/mm2 in all colours and shades, laid on 20 mm thick cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement and matching pigments shall be provided as per approved drawings. Size of Tile shall be 60X60 cm min.

10.2.12. Ist Quality Ceramic glazed floor Group V tiles (anti-skid) 300x 300 mm (thickness to be specified by the manufacturer) conforming to IS : 13755 of NITCO, KAJARIA ,BELL,JOHNSON, REGENCY, make shall be provided in toilet/pantry area in all colour shades as approved by Engineer-in-charge laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand) including pointing the joints with white cement and matching pigment etc. complete.

10.2.13. 1st quality ceramic glazed tiles conforming to IS : 13753 of minimum thickness 5mmof approved make like NITCO, BELL, JOHNNSON, REGENCY, KAJARIA make shall be provided in toilet/pantry area in all colours shade of any size as approved by engineer-in-charge in dados (height upto 2.1 m) over 12mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete.

10.2.14. 18 mm polished granite in cement mortar 1:4, 20 mm thick made to a level cut to size shall be provided and laid as per approved drawings. The joints are filled with jointing compound matching to the tiles. Wherever granite tiles are specified for the floor, 100mm granite skirting shall be provided with the

walls. The granite outer surface shall be flushed to the plaster finish of the wall .

10.2.15. Granite counter shall be provided and fixed in the pantry with 18 mm granite slab mounted on 75mm RCC slab supported by 115 mm brick wall plastered on all sides as per the approved drawing. The shelves are made of 18 mm thick well cut and polished white marble slabs. The outer side of the brick wall and the RCC slab visible in the front is finished with 18mm granite with edges moulded on the exposed end. The shutters shall be finished with 19mm particle finished laminate edge lipping. The shutters are to be provided with 100mm handles and shutter locks. The inside of the shutter shall be painted with synthetic enamel paint.

10.2.16. All Brick Works shall be with cement mortar 1:6 (1 cement: 6 coarse sand). Half brick work masonry shall be with cement mortar 1:4 (1 cement: 4 coarse sand**).** Bricks to be used shall be **fly ash bricks having compressive strength of 35 kg / Sq.cm as per approval of engineer in charge of CSPTCL.**

10.2.17. Anti termite treatment shall be carried out for all buildings, sheds, Bay Room bases etc. wherever required and as per direction of engineer in charge of CSPTCL.

10.2.18. M.S. Rolling shutters as per approved drawing shall be provided and fixed interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets along with ball bearing for rolling shutter, side guides and arrangements for inside and outside locking with push & pull operation including the cost of providing and fixing necessary 27.5 cm long wire springs grade No. 2 and M. S. top cover of required thickness for rolling shutters. 80 x 1.25 mm M. S laths with 1.25 mm thick top cover.

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

10.2.20. Anodised aluminium work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, anodised transparent or dyed to required shade according to IS : 1868. (Minimum anodic coating of grade AC 15) fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass/ stainless steel screws including glazing and fittings as specified. Shutters of doors, windows and ventilators shall be provided and fixed with hinges / pivots fittings wherever required including PVC/neoprene gasket.

10.2.20.1. SPECIFICATIONS FOR ALUMINIUM WORK :-

a) Aluminium anodised doors / ventilators made out of extruded aluminium section conforming to IS 733 IS: 1285 & IS: 1868 with outer frame size 101.6x44.45x1.90mm weighting 1.54 kg/m and shutter frame made from aluminium section 47.62x44.45x1.9mm weighting 0.97 kg/m for vertical style and top rail, bottom and lock rail are made from aluminium section 101.6x44.45x1.9mm weighting 1.64 kg/m including jointing with

extruded aluminium cleats neoprene rubber gasket bevelled edge beading screws and 5.0mm thick tinted glass for door and reflective glass for ventilator of good quality (weight 13.50 kg/sq.m) and make including all fittings of superior quality (decorative type) such as door handle tower bolts hinges etc. complete including applying a coat of lacquer, duly fixed in wall with 16x3.15 lugs 10cm long embedded in cc blocks 15x10x10cm size in cc 1:3:6 or with wooden plug and screws or with rawl plugs and screws or with fixing clips or with bolts and nuts as required as per direction of Engineer-in-charge.

b) Aluminium anodized two track sliding window made out of extruded aluminium section conforming to IS:733, IS:1285 & IS:1868 with outer frame size 63.50 x 38.10 x 18.0 mm weighting 1.148 kg/m and track top section of size 62 x 31.50 x 1.50 mm weighting 0.81 kg/m, shutter handle section 39.40 x 17.70 x 1.50 mm weighting 0.58 kg/m, interlock section 39.40 x 17.70 x 1.50mm weighting 0.60 kg/m, top & bottom section 39.40 x 17.70 x 1.50 mm weighting 0.55 kg/m, superior quality guide locks, neoprene whether strips and 5mm thick reflective glass of good quality and make (weight 13.50 kg/sq.m), complete including applying a coat a lacquer duly fixed in walls with 16x3.15mm lugs 10cm long embedded in CC blocks 15x10x10 cm size in CC 1:3:6 or with bolts and nuts as required as per direction of Engineer-in-charge.

c) Aluminium anodized three track sliding window made out of extruded aluminium section conforming to IS:733, IS:1285 & IS:1868 with outer frame size 101.6 x 44.45 x 1.99mm weighting 1.66 kg/m and track top section of size 91.8 x 31.7 x 1.50mm weighting 0.983 kg/m, track bottom section of size 91.8 x 31.7 x 1.50 mm weighting 0.58 kg/m shutter frame handle section 39.40x17.70x1.50mm weighting 0.58 kg/m, interlock section 39.40 x 17.70 x 1.50mm weighting 0.60 kg/m, top & bottom section 39.40 x 17.70 x 1.50mm weighting 0.55 kg/m, including superior quality guide locks, neoprene whether strips and 5mm thick reflective glass of good quality and make (weight 13.50 kg/sq.m), complete including applying a coat of lacquer duly fixed in walls with 16x3.15mm lugs 10cm long embedded in CC blocks 15x10x10cm size in CC 1:3:6 or with bolts and nuts as required as per direction of Engineer-in-charge.

d) Anodized aluminium framed grill of any size DG 102-7mm-fixed in suitable Y/U type channel as approved by Engineer-in-charge, including provided and fixing all hardware fittings of approved make required and fixing in walls with 16 x 3.15 mm lugs 10cm long embedded in CC block 15 x 10 x 10 cm size in cement concrete 1:3:6 (grill is to be fixed with suitable Y/H channel) complete as per direction of Engineer-in-charge.

e) Aluminium anodized fixed partition and like made out of extruded aluminium section conforming to LS:933, IS:1285 & IS:1868 with outer frame of size 63.5x38.1x1.80mm weighting 1.148 kg/m including jointing with extruded aluminium cleats neoprene weather stripping gasket bevelled edge beading screws and 5mm thick reflective glass (weight 13.50 kg/sq.m) including all fittings of superior quality (decorative type) such as door handle tower bolts hinges etc. complete including applying a coat of lacquer as per Direction of Engineer-in-charge duly fixed in walls with 16x3.15mm lugs 10 cm long embedded in CC blocks 15x10x10cm size CC 1:3:5 or with wooden plugs and screws or with rawl plugs and screws or with fixing clips or bolts as required.

10.2.21. Cement based water proofing treatment of roofs, balconies, terraces etc. shall be provided with average thickness of 120mm and minimum thickness at Khurra as 65mm and laid consisting of following operations:

a) A slurry coat of neat cement using 2.75 kg/m2 of cement admixed with proprietary water proofing compounds conforming to IS: 2645 shall be applied and grouted over the RCC slab including cleaning the surface before treatment.
b) Plain Cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 burnt brick aggregate of 40mm nominal size) admixed with proprietary water proofing compound conforming to IS: 2645 over 20mm thick layer of cement mortar of min 1:5 (Cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls upto 300mm height including rounding of junctions of walls and slabs.
c) After two days of proper curing, a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS: 2645 shall be applied.
d) The surface shall be finished with 20mm thick joint less cement mortar of mix 1:4 (1 cement : 4 course sand) admixed with proprietary water proofing compound conforming to IS: 2645 and finally the surface shall be finished with trowel with neat cement slurry and making of 300 x 300 mm square.
e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations shall be done in order and as directed and specified by the Engineer-in-charge.

10.2.22. Un-plasticised rigid PVC rain water pipes 110mm Diameter shall be provided and fixed on the wall face conforming to IS:13592 type A as per approved drawing including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion single socketed pipes.

10.2.23. Un-plasticised PVC Moulded fittings/accessories including 110mm bend and 110 mm shoes shall be provided and fixed for un-plasticised rigid PVC rain water pipes conforming to IS:13592 type A including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion.

10.2.24. Un-plasticised PVC pipe clips of approved design shall be provided and fixed to un-plasticised 110mm PVC rain water pipes by means of 50x50x50mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar1 :4 (1 cement : 4 coarse sand) and making good the wall etc.

10.2.25. Double action hydraulic floor spring of approved brand and manufacture IS: 6315 marked "Hardwyn" make (Model 3000) or equivalent for doors shall be provided and fixed at the following door including cost of cutting floors as required, embedding in floors and cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer-in-charge. With stainless steel cover plate :

a) Main Entrance to Control Room Building
a) S/S in charge room
b) Control Room
c) Camping House
d) Bay marshalling Rooms

10.2.26. Plinth protection 75 mm thick min. 1.0 m wide of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone) aggregate 20 mm nominal size)

shall be laid over 100 mm bed of PCC (1:3:6) and shall be grouted with fine sand including finishing the top smooth. Coloured vitreous china pedestal type water closet (European type) with seat and lid, 40mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design including painting of fittings and brackets, cutting and making good the walls and floors shall be provided for all toilets.

10.2.27. Coloured vitreous china wash basin of size 630 x 450mm with C.I/M.S brackets along with single15 mm C.P brass pillar taps, Kingston/Gem/Techno/Parko, 32 mm C.P brass waste of standard pattern, shall be provided and fixed in the toilets including painting of fittings and brackets, cutting and making good the walls wherever required along with C. P brass trap and C.P brass union. All urinals shall be coloured vitreous china flat back half stall urinal of 580x380x350mm with 10 litre PVC automatic flushing cistern, Parryware/Hindware/Seabird/Orient (Coral) with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS:2556 C.I. trap with outlet grating and other couplings in C.P. brass including painting of fittings and cutting and making good the walls and floors wherever required.

10.2.28. Following fittings shall be provided in all the toilets:

a) Toilet paper roll holder.
b) Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.
c) CP/PP liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP /PP brackets, CP screws, washers, plugs etc.
d) 100mm Diameter vitreous chinaware half round channel of approved make fixed to correct grade, level, opening for floor trap below urinals set in CM 1:3 & pointed using white cement etc .
e) CP brass bibcock 15mm nominal bore of approved quality conforming to IS: 8931.
f) CP brass angle valve of 15mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS :8931.
g) Best quality marble partition slab provided and fixed in position for urinals, of size 610x1150mm, 20mm thick, polished on both sides &machine cut, exposed corners rounded etc.
h) Towel rail of approved make of 600mm length, 25mm Diameter with a pair of brackets or flanges provided and fixed to wall beside each wash basin/set of washbasin with necessary screws, plugs, etc.
i) 6 mm thick bevelled edge mirror 1000x600mm shall be provided and fixed mounted on 12mm thick water proof plywood backing and hardwood beading all-round and mirror fixed to the backing with 4 Nos. of CP cap screws & washers, including fixing the mirror to the wall with necessary screws, plugs & washers etc., with each wash basin.

10.2.29. Stainless steel ISI 304 (18/8) Kitchen sink of 510x1040mm bowl depth 178mm with drain board shall be provided and fixed as per IS 13983 with C.I brackets, and stainless steel plug 40mm including painting of fittings and brackets, cutting and making good the wall.

10.2.30. GI Pipe work for Internal and External works:

a) All concealed GI pipes and fittings shall be ISI marked and shall be painted with anticorrosive bitumastic paint including cutting of chases and making good the wall.
b) All exposed GI pipes and fittings shall be painted with synthetic enamel paint of desired shade over a ready mixed priming coat, both of approved quality for new work.
c) Wherever GI pipes are buried, the same shall be provided and laid in position including trenching sand cushion and refilling, painted with anticorrosive bitumastic paint etc.
d) Gun metal ball valve with operating levers, non-return valves conforming to IS specification shall be provided and fixed in position as per approved drawing or direction of Engineer-in-charge.

10.2.31. Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 50 class designation brick work in cement mortar 1:5 (1 cement : 5 fine sand) with CI surface box 100 mm. Top diameter, 160 mm bottom Diameter and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1cement : 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with FPS bricks of class 75.

10.2.32. Two numbers of 1000 litres capacity each and five numbers of 1000 litres capacity each HDPE water storage tanks of approved brand and manufacture with cover and suitable locking arrangement, float value and making necessary holes for inlet, outlet and overflow pipes shall be provided and placed on roof of control room building and camping house respectively.

10.2.33. PVC floor traps of self-cleansing design shall be provided & fixed in position with outlet size of 75mm diameter of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150 mm thick PCC 1:2:4, providing &fixing of top tile & strainer of CP or PVC on top of the trap etc.

10.2.34. Square-mouth SW gully trap grade 'A' 100x100mm size P type with FPS Bricks class designation 75 shall be provided and fixed complete with CI grating brick masonry chamber with water tight C.I. cover with frame of 300X300mm size (inside) the weight of cover to be not less than 4.5 Kg and frame to be not less than 2.70 Kg as per standard design.

10.2.35. Glazed stoneware pipes of 150mm diameter grade 'A' shall be provided, laid and jointed with stiff mixture of cement mortar in the proportion of 1:1 (1cement :1 fine sand) including testing of joints etc. complete.

10.2.36. Cement concrete 1:5:10 (1 cement :5 coarse sand : 10 graded stone aggregate 40 mm nominal size) shall be provided and laid around S.W pipes including bed concrete.

10.2.37. Brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement :4 coarse sand) RCC top slab with 1:2:4 mix (1 cement : 2coarse sand : 4 graded stone aggregate 20 mm nominal size) foundation concrete 1:4:8 mix (1cement : 4 coarse sand :8 graded stone aggregate 40 mm nominal size) inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1 cement: 2 coarse sand :4

graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement complete as per standard design.

10.2.37.1. Inside size shall be 90 x 80 cm and 60 cm deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and shall be constructed with F.P.S. bricks with class designation 75.

10.2.37.2. Inside size shall be 120 x 90 cm and 90 cm or more deep including CI cover with frame (medium duty) 500mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) with FPS Bricks class designation 75.

10.2.38. MS foot of 20 x 20mm square rests shall be provided and fixed in manholes with 20 x 20 x 10 cm cement concrete blocks 1:3:6 (1 cement :3 coarse sand :6 graded stone aggregate 20 mm nominal size) as per standard design.

10.2.39. Steel glazed doors, windows and ventilators of standard rolled steel sections shall be provided and fixed in FFPH building, joints mitred and welded with 15 x 3 mm lugs, 10cm long, embedded in cement concrete blocks 15 x 10 x1 0 cm of 1:3:6 (1 cement 3 coarse sand : 6 graded stone aggregate 20mm nominal size) or with wooden plugs and screws or rawl plugs and screws or with fixing clips or with bolts and nuts as required, including providing and fixing of glass panes with glazing clips and special metal sash putty of approved make complete including applying a priming coat of approved steel primer, necessary hinges or pivots as required.

10.2.40. Pressed steel door frames manufactured from commercial mild steel sheet of 1.25mm thickness shall be provided and fixed in FFPH building including hinges jamb, lock jamb, bead and if required angle threshold of mild steel angle of section 50x25mm, or base ties of 1.25 mm pressed mild steel welded or rigidly mixed together by mechanical means, adjustable lugs with split end tail to each jamb including steel butt hinges 2.5mm thick with mortar guards, lock strike-plate and shock absorbers as specified and applying a coat of approved steel primer after pre-treatment of the surface as directed by Engineer-in-Charge.

10.2.41. Asbestos cement 6mm thick corrugated sheets roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8mm diameter G, I plain and bitumen washers complete including the cost of purlins, rafters and trusses for fire fighting water tank covering.

10.2.42. All the internal walls (except for cladded portion) shall be rendered smooth using water proof putty of reputed and approved brand as per direction of Engineer in charge.

10.2.43. The battery room shall have acid resistant tiles of Group V in approved colour and shade of reputed and standard make with acid resistant joint filler on floor and wall up to 2500 mm height. Above 2500 height acid proof paint shall be painted up to roof level. A wash basin shall be provided in the battery room.

10.2.44. Anti-skid tiles of reputed and approved make, quality class, pattern, colour and shade shall be provided in portico as per approved drawing and direction of engineer in charge of CSPTCL.

10.2.45. Electrical wirings including fittings: MMS CPVC conduit concealed system with 7/20 PVC copper wire shall be used for power circuit and 3/20 PVC copper wire for L&F circuits. Fixtures are to be provided as per approved lighting layout, Luminaries are to be provided in excess so as to meet out

minimum LUX level prescribed by CBIP even with 40% outages of light. Similarly, 1200 mm sweep size ceiling fans are to be provided 1 No. per 10 sq. M. of ceiling area. Exhaust fans of standard and approved make are to be provided in Battery room, toilet, store, record room etc. and wherever required as per approved drawings. In addition to the A.C. Wiring as above, 2 nos. 100-Watt bulbs shall be connected in the control room from the D.C. Supply output through automatic change over contactor. Also concealed wiring for telephone connection LAN points shall be provided as per direction of Engineer-in-charge.

10.2.46. In Control Room building, all doors, windows, ventilators shall be of Aluminium Sections semi glazed /fully glazed/panelled with tinted glasses minimum 5 mm thick in case of doors and 3 mm thick in case of windows. . All the windows, ventilators, exhaust fan openings etc. shall be provided with Aluminium grills. All windows shall be three track aluminium windows. The third track shall have shutter with aluminium mosquito net of good quality.

10.2.47. In the Store Room, loft shall be provided at the lintel level all around.

10.2.48. All the materials such as HYSD bars, MS rounds, MS angles, cement, barbed wire, G.I. wire mesh, chequered plates, bricks, etc. shall conform to relevant IS specifications. The water supply fittings, fixtures, PVC pipes, fittings, fixtures, G.I. pipes (medium class), fittings, fixtures, water tank, exhaust fans, wires, cables, electrical fixtures etc. will be ISI marked and approved by the purchaser. Approved quality of brick with minimum compressive strength of 35Kg per centimetre square shall be used in construction. The metal for construction work shall be crusher broken Black Trap, Granite , Basalt variety only and sand shall be from river bed and free of silt. Soft and light variety of sand stone metal and lime stone metal i.e. reddish/pinkish metal shall not be used in any manner in construction activity.

10.2.49. Foundations shall be raised above finished yard level up to height as per standard practice/as per approved drawings.

10.2.50. It shall be responsibility of successful bidder to ensure effective and efficient drainage of all rainwater of substation area through drainage system up to nearest available natural outlet as per approved drawing and directions of Engineer in charge of CSPTCL.

10.2.51. Main gate supported on RCC posts with mesh covered decorative lamps in front of control room.

10.2.52. Sub-station Glow Sign Board 6’ x 4’ size on top of 400 KV control room front side with GI structure supports with internal tube light arrangements for illumination mentioning “CSPTCL 400 KV Sub-Station, Dhardehi, Distt. Bilaspur.”

10.2.53. 400 KV substation Signboard (6’x4’ size) in front of substation with GI steel structure support with illumination arrangement.

10.2.54. SINGLE LINE DIAGRAM: 6’x4’ board showing the single line diagram of the substation shall be provided by the contractor in the control room.

10.2.55. Level survey of substation site and nearest available natural outlet for drainage shall be done and contour drawing shall be prepared. Based on existing levels of ground, approach road and nearest available natural drainage, proposal for fixing various levels of substation shall be submitted for approval of competent authority of CSPTCL. Levels shall be finalized in such a manner that all the rain water in case of worst possible rain storm

gets discharged through drainage system up to nearest available natural drainage outlet and no rain water gets accumulated in substation area.

10.2.56. All roof parapet wall junctions, chajja wall junctions shall be provided with hollers of adequate dimensions as per direction of Engineer-in-charge of CSPTCL. Minimum 40 mm thick coping in 1:1.5:3 mix concrete shall be provided over parapet.

10.2.57. The slabs of control room building shall be projected at least 750 mm beyond outer side of outer wall and drip course shall be provided on extended portion.

10.2.58. Backfilling shall be done as per direction of engineer in charge of CSPTCL using approved backfill material which shall be well compacted at optimum moisture content in layers of thickness not exceeding 200 mm loose thickness using proper compactor as per direction of engineer in charge of CSPTCL.

10.2.59. The loading/unloading gantry structure shall be designed for minimum 5 tonne load lifting capacity.

10.2.60. Calcium Silicate false ceiling boards shall be minimum 8 mm thick and shall be of reputed make approved by engineer in charge of CSPTCL prior to use.

10.2.61. Standard construction practices as per relevant IS codes and as per direction of Engineer-in-charge of CSPTCL shall be followed wherever not specifically mentioned in the tender documents.

10.2.62. All the construction materials, fixtures, fittings etc. shall be of reputed make and shall be got approved from Engineer-in-charge of CSPTCL prior to use.

10.2.63. Necessary cable trenches and ducts etc. as per requirement shall be provided in C/R building for carrying cables at GF & FF level.

10.2.64. **PARKING SHED** : This shed is meant for parking of two/four wheelers. This shed will have color coated profile sheet roofing on tubular truss, purlins structure, wind ties, etc. The flooring shall be 100 mm thick PCC 1:2:4 over 150 thick PCC 1:3:6 which will be laid over well compacted sub base. The flooring shall be provided in area one metre wider on each side than roof area in plan.

10.2.65. **4 BAY STORE SHED: -** This building will be 4 bay shed with color coated profile sheet roofing. The Bay span will be 4m x 8m with clear min floor height of 3.3 m between floor top level to bottom level of sheet at eaves gutter end. The plinth height shall be as per site condition/approved drawing. Two bays meant for unloading shall be open i.e. without brick walls but with roofing, Hardcrete flooring, painting, electrification etc., while two bays meant for store shall have brick wall, internal and external plastering, electrification, painting, M.S. sheet / wooden panelled doors, steel/ aluminium windows/ ventilators with M.S. / aluminium grills, rolling shutters, ramps, Hardcrete flooring etc. complete as per specifications for buildings mentioned above. The roofing shall extend at least 750 mm beyond wall outer face or floor outer face. The contractor shall be required to complete all the works of shed as per drawing approved by CSPTCL. The bays meant for unloading shall have mechanised unloading facility which shall have capability to shift loads upto 5 MT anywhere in the unloading shed.

10.2.66. **GUARD ROOM WITH ATTACHED TOILET:-** The contractor shall be required to construct architecturally attractive guard room measuring about 10 sq.m in plinth area preferably with sloping roof and hexagonal lay out in

plan with min. two no. of glazed aluminium windows with aluminium grills and min. one no. teak wood panelled wooden door, nice looking exterior finish using ceramic/terracotta /other kind of tiles or materials on wall and roof and ceramic tile (group V)flooring in approved shade and colour of BELL, REGENCY, KAJARIA, JOHNSON, NITCO make . The guard room shall have attached toilet about 4 sq. m plinth area with EWC , wash basin, ceramic tile flooring and skirting upto 2.1 m on walls , Taps etc . as per aforementioned specifications complete in all respects with one no. PVC door at bath entrance, aluminium louver ventilator with grill, exhaust fan etc. The numbers of door / windows may be more than min. numbers mentioned above. The contractor shall be required to complete all the works of guardroom with attached toilet as per drawings approved by CSPTCL.

10.2.67. **BAY MARSHALLING ROOM: -** The contractor shall be required to construct air conditioned (with two nos. 2 T split air conditioners) Bay Marshalling rooms mounting Bay control units/protection/PLCC panels as per the specification drawing. The size of the room shall be approx. 6.5mx4.5mx3.5m.There may be minor variation of size of the room as per the size requirement. There shall be proper cable entry arrangement with proper water and air tight sealing of the said cable entry point. The cable entry shall be from below. The contractor shall be required to complete the work in all respects as per specifications and drawings approved by the CSPTCL.

10.2.68. **CABLE TRENCHES: -** The cable trenches shall be of RCC, of section as per design requirement with adequate provision for drainage purpose with RCC covers min. 90 mm thick with reinforcement on top and bottom both. The trenches shall be laid at gradient not flatter than 1 in 1000 to ensure effective drainage. The main trenches shall be connected to Main drainage system.

10.2.69. **FIRE RESISTANT WALL:-** The fire resistant walls shall be of RCC and of dimensions to ensure complete fire protection to transformers as per IS 1641,IS 1642 ,IS 456 and other relevant applicable IS codes .The wall may be Zigzag in plan as per guidelines in applicable IS codes and shall have min. 1.5 m projection beyond outer face of outermost part of transformers / transformer accessories in all directions .Additional measures such as application of fire resistant finishes, provision of fire resistant false ceilings and sacrificial steel in tensile zone , on wall faces shall also be provided as per relevant applicable IS codes to give protection against spilling. The wall shall be designed for a fire resistance of min. 4 hours, which may be more if required so as per guide lines in applicable IS codes.

11.0 MODE OF MEASUREMENT

11.1. ROADS - The measurement for the concrete roads shall be made in running metres measured along the centre line of the road and shall include all items such as excavation, compaction, rolling, watering, WMM, side drains etc. complete as per specifications and approved drawings. The rates quoted for roads shall also include cost towards providing additional drains of any section and size as per direction of engineer in charge of CSPTCL or as per approved drawing required for effective drainage of entire S/S area in addition to side drains of road such as for connection of main drains to natural drainage system of the area etc.

11.2. CHAIN LINK FENCING AND GATE - The measurement shall be made in running metres of the fence provided as per specifications and approved

drawing. The rate shall be including the post, fencing, MS Flat etc. complete. The gate shall be measured in numbers.

11.3. **CONTROL ROOM CUM ADMINISTRATIVE BUILDING -** This is a lump sum item for building. The entire work required to complete the building in all respect as per the specifications and drawings approved by the CSPTCL shall be deemed included in this lump sum rate.

11.4. **FIRE FIGHTING PUMP HOUSE WITH WATER TANK AND COMPLETE EXCLUSIVE WATER SUPPLY SYSTEM -** This is a lump sum item. The contractor shall be required to complete the work in all respect as per specifications and drawings appended /approved by the CSPTCL. All the items required for execution as per specifications and appended/approved drawing by CSPTCL shall be deemed to be included in the lump sum rate including excavation, compaction, brick work, roof truss, color coated profile sheet roofing, all types of miscellaneous works, steel, internal and external plastering, painting, bore well, submersible pump, pump house for submersible pump, exclusive water supply system for fire fighting etc. complete in all respects.

11.5. **PARKING SHED -** The contractor shall be required to complete the work in all respect as per specifications and drawings approved by the CSPTCL. All the items required for execution as per specifications and approved drawing by CSPTCL shall be deemed to be included in the quoted rate including excavation, compaction, brick work, flooring, roof truss, color coated profile sheet roofing, all types of miscellaneous works, painting etc. complete in all respects. The quantity for payment shall be measured in sq.m of roof area in plan.

11.6. **STORE CUM UNLOADING SHED -** The contractor shall be required to complete the work in all respect as per specifications and drawings approved by the CSPTCL. All the items required for execution as per specifications and approved drawing by CSPTCL shall be deemed to be included in the quoted rate including excavation, compaction, brick work, flooring, roof truss, color coated profile sheet roofing, all types of miscellaneous works, doors, windows, structural steel works, internal and external plastering, painting ,electrification etc. complete in all respects. The quantity for payment shall be measured in sq, m of plinth area.

11.7. **GUARD ROOM WITH ATTACHED TOILET -** The contractor shall be required to complete the work in all respects as per specifications and drawings approved by the CSPTCL. All the items required for execution as per specifications and approved drawing by CSPTCL shall be deemed to be included in the quoted rate. The quantity for payment shall be measured in sq, m of plinth area.

11.8. **FIRE RESISTANCE WALL -** The contractor shall be required to complete the work in all respects as per specifications and drawings approved by the CSPTCL. All the items required for execution as per specifications and approved drawing by CSPTCL shall be deemed to be included in the quoted rate. The quantity for payment shall be measured in nos. of walls constructed.

12.0 **MISCELLANEOUS GENERAL REQUIREMENTS**

12.1. Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

12.2. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stopper with central bulb. However, kicker type (externally placed) PVC water stopper shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stopper shall be 5 mm and minimum width shall be 230 mm.

12.3. All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS:3416.

12.4. Fly ash Bricks having minimum 35 kg/cm2 compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 35 kg/cm2 compressive strength before submitting his offer.

12.5. Angles 50x50x5 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.

12.6. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS:6313 and other relevant Indian Standards.

12.7. For all civil works covered under this specification, nominal mix by volume batching as per specification is intended. The relationship of grade of concrete and ratio of ingredients shall be as below:

S. No.	Mix	Cement	Sand	Coarse aggregate of 20 mm down grade
1.	M 10	1	3	6
2.	M 15	1	2	4
3.	M 20	1	1.5	3

12.8. The material specification, workmanship and acceptance criteria shall be as per relevant clauses of PWD specification and approved standard Field Quality Plan.

12.9. M.S. angles of min. size 50x50x6 @ 500 mm c/c shall be provided in cable trenches to support cables where cable trays are not provided. Suitably designed angles shall be provided to support cable trays.

12.10. Chequered plates of min. 6 mm thickness with designed supports shall be provided over trenches inside building.

12.11. 12.8 Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

13.0 INTERFACING

13.1. The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of Foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut

outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

14.0 STATUTORY RULES

14.1. Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control, Indian Electricity Act etc.

14.2. Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

14.3. Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation.

14.4. All building/construction materials shall conform to the best quality specified in specifications if not otherwise mentioned in this specification.

14.5. All tests as required in the standard field quality plans have to be carried out.

14.6. The contractor shall deploy at site a team of qualified engineers comprising at least one degree holder and two diploma holders in civil engineering to supervise civil works all the time.

14.7. Quality control lab shall be provided at site for testing of constructional material. In the lab equipments tools and plants shall be provided for compressive strength testing of bricks, concrete, fineness modulus of sand, equipments for measuring optimum density after compaction, proctor density apparatus etc. and any other equipment required for measuring parameters mentioned in approved drawings and as per direction of engineer in charge of CSPTCL.

15.0 CAMPING HOUSE :

15.1. The fully furnished camping house shall be got completed and made operational before the commencement of erection of structures of 400/200 KV switchyard.

15.2. SPECIFICATIONS FOR FURNISHING OF CAMPING HOUSE

15.2.1. Modular bed: Overall size: 1875mm X 900mm - Head & foot side should be made up of 18mm ISI marked pre-laminated particle board of reputed make with edge covered with PVC edge bands. Centre portion up of 18mm edge covered with PVC edge band.

15.2.2. Mattresses Overall size : 1875mmX910mmX100mm - With one side foam & one side coir ISI marked make century /Kurlon/ Sleep well.

15.2.3. Pillow: Overall size :24”X15”Make Century /Kurlon/Sleep wall.

15.2.4. Wooden sofa set 3+1+1 - Structure complete made up of Teak Wood. Seat made up of 4”50 density foam. Back made up of 3” 32 density foam. The complete seat & back to be covered with good quality cloth.

15.2.5. Centre Table: Overall Size : 1200mmX600mmX450mm - Frame made up of teak wood with polish. Top made up of 12mm thick tinted glass with polished edges.

15.2.6. Study Table Overall size:1200mmX600MMX450mm - With one drawer and one cupboard. Top made up of 18mm ISI marked pre-laminated particle board of reputed make with edge covered with PVC edge bands. Structure made up of 18 mm & 12mm ISI marked pre-laminated particle board of reputed make with edge covered with PVC edge bands.

15.2.7. Study Chair - With arm & cushion seat & back. Structure made up of rubber wood press ply. Seat & back made up of high density foam covered with good quality matte cloth.

15.2.8. Steel Almirah Overall size 1980mmX965mmX560mm - With door shutters of 20 gauge & body of 22 gauge sheets painted with good finish & with provision for hanging arrangement, tie rod one locker & three shelves.

15.2.9. Dressing Table - Dressing Table with stool complete frame made up with teak wood with drawer, glass 4mm thick.

15.2.10. Dining Table with Six Chairs: Overall size 1800mmX900mmX750mm - Dining Table With Six Chairs, top made up of 18mm ISI marked pre-laminated particle board of reputed make. Edge covered with teak wood beading. Frame made up of teak wood. Chairs shall be made up of teak wood.

15.2.11. Split air conditioners - Split air conditioners 2T capacity conforming to relevant IS of some reputed make like Carrier, Voltas, Diken.

15.2.12. Refrigerator 275 L - Frost Free Refrigerator of 3 star rating conforming to relevant IS of some reputed make like Godrej, Samsung, LG.

15.2.13. Full HD,1080p, LED TV 32 inches One number make Sony/Samsung

15.2.14. Microwave Oven(25 L) : Samsung / LG make

15.2.15. Steel & Bone china Dinner sets Reputed make

15.2.16. Curtain Shall be best quality cotton door and window of reputed make.

15.2.17. Geyser shall be provided in all the bathrooms/toilets

TECHNICAL SPECIFICATION
400/220/33 KV,315 MVA AUTOTRANSFORMER

1 General

1.1 This specification covers design, engineering, manufacture, testing at manufacturer's works, delivery at site including all materials, accessories, spares, unloading, handling, proper storage at site, erection, testing and commissioning of the 400/220/33KV, 315 MVA Transformers.External or internal reactors shall not be used to achieve the HV/LV and IV/LV impedance specified.

1.2 TECHNICAL PARAMETERS : THREE PHASE , 315 MVAAUTO TRANSFORMER

Sl. No	ITEM	Specification of 315 MVA X'mer
1.	Rated Voltage Ratio: kV	400/220/33 KV
2.	No.of windings	Auto transformer with tertiary
3.	MVA rating a) HV/IV b) LV(Tertiary)	 315 MVA / 315 MVA 105 MVA
4.	No. of phases	Three
5.	Frequency	50 Hz
6.	Type of cooling	ONAN/ ONAF/OFAF
7.	MVA rating corresponding to cooling system: a) ONAN Cooling b) ONAF Cooling c) OFAF Cooling	 60% 80% 100%
8	Rated current of HV side at (-)10% volts tap & what will be the Temp. Rise & Losses if 10% continuous over loading done on (-) 10% tap.	**Please furnish**
9	Transformer KVA rating at 105% over voltage	The transformer shall be capable of delivering rated current at a voltage equal to 105% of the rated voltage
10.	Method of connection a) Windings b) Neutral	 HV & IV –Star , LV –Delta Solidly grounded
11.	Connection Symbol (Vector group)	YN a0 d11,
12.	System earthing	Effectively earthed
13.	) HV-IV impedance at 75 deg C i. Max. Voltage tap ii. Principal tap iii. Min. Voltage tap b) HV-LV impedance c) IV-LV impedance	 10.3% 12.5% 15.4% 60%* 45%* * Impedance are minimum indicative only.

Sl. No	ITEM	Specification of 315 MVA X'mer
14.	Anticipated continuous loading of windings: a) HV and LV b) Tertiary	 **Not to exceed 110% of its rated capacity** Suitable for no load operation as well as for loading to its rated capacity with capacitive or inductive loading or combination of both. (subject to a maximum of 33% of the rated capacity of HV winding).
15.	Tap changing gear:- 1) Tap range & steps 2) Tap control	-Tap changer shall be located on 220 KV side of the series winding for achieving -10% to + 10% of HV variation in the steps of 1.25%. -Full capacity – on load tap changer suitable for group / independent , remote/local electrical and local manual operation & bi- directional power flow
16.	Over voltage operating capability and duration	125% rated voltage for 60 secs. 140% rated voltage for 5 secs.
17.	Minimum Air core reactance of HV windings.	20%
18.	(a) Max. Flux density in any part of core and yoke at rated MVA, voltage and frequency shall be such that under 10 % continuous over voltage condition it does not exceed . (b) No load current of the transformer at 105%of rated voltage (c) Current density in winding	**1.9 Tesla (Maximum)** **0.5% of rated current (maximum)** <= **3 Amp/ sq. mm (max.)**
19.	Insulation levels: For windings a)1.2/50 microsecond impulsewithstand voltage (kVp) b)20/200/500microsecond switching surge withstand voltage (kVp) c) Power frequency withstand voltage (kV rms.)	HV IV LV 1425 950 250 1050 -- -- 630 460 95
	d) Tan delta values of winding	The measured Tan delta values of winding shall not exceed 0.45% at 20^0C temperature. In case Tan delta of transformers during testing at works of manufacturer is measured above maximum ceiling of 0.45% at 20^0C temperature, then CSPTCL reserves right not to accept such of the transformer.

Sl. No	ITEM	Specification of 315 MVA X'mer
20.	Type of winding insulation:- a) HV/IV winding b) LV winding	 Graded Full
21.	System short circuit fault level and duration for which the transformer shall be capable to withstand thermal and dynamic stresses (kA rms/sec)	The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs with the subject transformer connected at infinite bus.
22.	Maximum partial discharge level at 1.5/sq.root 3 of rms. Phase to ground voltage.	500 pico coulombs
23.	Noise level at rated voltage and frequency	81 dB
24.	Permissible temperature rise: Over ambient temp . i) Of top oil measured by thermometer. ii) Of winding measured byresistance.	 40^{0} c 45^{0} c
25.	Minimum clearances in air (mm): a) HV b) IV c) LV	Phase to Phase / Phase to ground 4200 / 3500 2100 / 2100 320 / 320
26.	Terminal Bushings(OIP condenser bushing) :- a) HV Winding Line end b) IV Winding Line end c) HV/IV Winding Neutral d) LV Winding	 420 KV 245 KV 72.5KV 72.5KV with center spacing of 1000 mm.
27.	Max. Radio Interference voltage level at 1 MHz & 1.5/sq root 3 of rms phase to ground voltage for HV winding	1000 micro volts
28.	Minimum Visual Corona extinction voltage a) For 400 KV System b) For 220 KV system	 320 KV rms 156 KV rms
29.	Cooling Equipment's: No. of Banks with adequate number of Fans/oil pumps , standby fans/oil pumps etc. with oil flow indication.	Two Banks each 50% radiator

Sl. No	ITEM	Specification of 315 MVA X'mer			
30.	Bushings:				
		HV	IV	LV	Neutral
	1) Voltage Rating (kV rms)	420	245	72.5	72.5
	2)Current Rating	1250	1250	3150	1250
	3)Insulation level:				
	a) 1.2/50 micro sec.lightning impulse with stand voltage (kVp)	1425	1050	325	325
	b) 250/2500micro.sec.swiching impulsewith stand voltage (kVp)	1050	---	---	-----
	c) 1 Minute power frequency withstand voltage (kV rms)	630	460	140	140
	4) Min.Total Creepage distance (mm)	10500	6125	1813	1813
31.	(I) Maximum & Minimum Losses at rated voltage & frequency at 75 dgree C	Maximum		Minimum	
	a) No Load Losses (Iron Losses) KW	90		81	
	b) Load (Copper Losses) KW	475		427.5	
	c) Auxiliary Loss KW	20.0		18.0	
	(II) No load losses at 110% of rated voltage & rated frequency	Not more than 130% of the losses at rated voltage & frequency			
32.	Bushing CTs for REF Protection	Two cores each of Bushing CTs of adequate ratio should be provided in HV, IV and neutral bushing for REF protection.			
33	Bushing CTs forWTI	One core each in middle phase of HV,IV and LV wdgs. Suitable turns ratio as per manufacturer's practice.			
33.	Service	Out door			
34.	Duty	Continuous			

Sl. No	ITEM	Specification of 315 MVA X'mer
35.	Transformer Oil.	
	1 Appearance	The oil shall be clear and transparent and free from suspended matter or sediment.
	1 Density at 27^{o} C max.	0.89g/cm^3
	2 Kinematic viscosity max.	
	a) At 27 ^{o} C	27 cSt.
	b) Sub-zero temp.	Under consideration.
	3 Interfacial tension @ 27 degree min,	0.04N/m
	4 Flash point Penskymartn (closed) min.	140 degree centigrade
	5 Pour point max.	-10^{o}C
	6 Neutralization value (total acidity) max.	0.01mg. KOH /g
	7 Corrosive sulfur (in terms of classification of copper strip)	Non corrossive
	8 Electric strength (break-down voltage)	50 kv (RMS) If the value is not attained the oil shall be treated.
	a) New untreated oil	75 kv (rms)
	b) After treatment	0.005
	9 Dielectric dissipation factor (tan delta) at 90^{o} C max	$35x10^{12}$ ohms-cm
	10 Specific resistance (resistivity)	$1500x10^{12}$ ohms-cm
	a) At 90 ^{o} C min.	0.20 KOH/g
	b) At 27 ^{o} C min.	0.05 % by weight
	11 Oxidation stability	The oil shall not contain antioxidant additives
	a) Neutralization value after oxidation (max)	
	b) Total sludge after oxidation (max)	
	12 Presence of oxidation inhabitor	
	14 Water content (max)	
	a.) New untreated oil	30 ppm
	b.) After treatment	10ppm
	15. Prior to energisation at site acceptance norms.	
	a.) BDV (KVrms)	75 KV (Min.)
	b.) Moister containt	10 ppm (max.)
	c.) Tan- Delta of X'mer oil at 90 deg C	0.003 (Max.)
	d.) Resistivity at 90 deg C	$1x10^{12}$ ohms-cm (Min.)
	e.) IFT	0.03/m (Min.)

2 **Performance**

2.1 The autotransformers shall be used for bi-directional flow of rated power.

2.2 Transformers shall be capable of operating under natural cooled condition upto the specified load. The forced cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the

transformer shall operate as a forced cooling unit initially as ONAF upto specified load and then as OFAF. Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for atleast ten (10) minutes without the calculated winding hot spot temperature exceeding 150^0C. Transformers fitted with two cooler banks, each capable of dissipating 50 per cent of the lossesat continuous maximum rating, shall be capable of operating for 20 minutes in the event of failure of the oil circulating pump or blowers associated with one cooler without the calculated winding hot spot temperature exceeding 150^0C at continuous max. rating. The contractor shall submit supporting calculations for the above for CSPTCL's approval.

2.3 The transformers shall be capable of being operated, without danger, on any tapping at the rated MVA with voltage variation of ± 10% corresponding to the voltage of the tapping.

2.4 **The maximum flux density in any part of the core and yoke at the rated MVA and frequency shall be such that under 10 per cent continuous over voltage condition it does not exceed 1.9 Tesla.**

2.5 Radio Interference and Noise Level

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

2.5.2 The noise level of transformer, when energised at normal voltage and frequency with fans and pumps running shall not exceed the values specified in NEMA standard , when measured under standard conditions.

2.6 The transformers shall be capable of being loaded in accordance with IS: 6600/IEC-354.There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

2.7 The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs with the subject transformers connected at infinite bus.

The system fault level may be taken as 50 kA (symmetrical,rms, 3 phase fault on 400 KV & 220 KV) & 25 kA (symmetrical, rms, 3 phase fault on 33 KV).

2.8 Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

2.9 Transformers shall withstand, without injurious heating, combined voltage and frequency fluctuations which produce the following over fluxing conditions:

i) 125% for 1 - minute 140 % for 5 sec

ii) Bidder shall indicate 150% and 170% over voltage withstand time.

2.10 The air core reactance of HV winding of transformer shall not be less than 20%.

2.11 **Tertiary Windings for autotransformer**.

2.11.1 The tertiary windings shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching. All the windings shall be capable of withstanding these stresses that may be caused by such switching.

2.11.2 The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals.

2.11.3 The tertiary winding shall be suitable for connection to LT Transformer for auxiliary supply.

2.11.4 **Tertiary winding**:-For 315 MVA transformer, ONAF rating of HV & IV shall be 315 MVA and that of 33 KV LV (tertiary) rating shall be 105 MVA .The tertiary of 315 MVA transformer shall be designed for full rated MVA loading of either capacitive or inductive or mixed load. The tertiary winding shall not have taps. Tertiary winding shall be without tap changer. The tertiary winding is intended to be loaded for the specified rating as mentioned above and accordingly terminals of delta winding needs to be brought out on transformer through three bushings. One 33 KV class CT of ratio 1000/1-1 Amps having two secondary cores of rating 1Amp, one of accuracy class 5P20 and other of accuracy class 1 shall be provided in any one phase of tertiary winding before delta formation for monitoring circulating current and also to provide protection against circulating current beyond rated capacity.

One No. PS class CT shall be provided in each phase of the tertiary bushing for Differential protection. One CT core of suitable ratio shall be provided in the middle phase for monitoring WTI. For measurement of circulating current of delta winding one Ampere meter of digital /numeric type suitable for specified CT ratio shall be provided on the RTCC panel. The tertiary winding shall be designed to carry the fault current under worst fault condition.

3 Construction Details

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

3.1 Tank and Tank Accessories

3.1.1 Tank

a) Tank shall be of welded construction and fabricated from tested quality low carbon steel of minimum thickness of 25 mm. (Base & Tank cover) and 12mm for sides.

b) All seams and those joints not required to be opened at site shall be factory welded and whenever possible they shall be double welded. After completion of tank construction and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing member. The requirement of post weld heat treatment for tank/stress relieving parts shall be based on recommendations of BS: 5500 table 4.4.3.1

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

d) The tanks shall be designed to withstand
   (i) Mechanical shocks during transportation
   (ii) Vacuum filling of oil at 10 millitorr
   (iii) Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.
   (iv) Short circuit forces.

e) Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipes.

f) Adequate space shall be provided at the bottom of the tank for collection of sediments. The minimum clearance of outermost winding/connection leads to tank shall not be less than 300 mm on all 4 sides to allow free movement of two persons for inspection. Suitable platforms may be provided on bottom to facilitate free movement of person all around inside the tank. The arrangement should be brought out clearly in the drawing.

g) The base of each tank shall be so designed that it shall be possible to move the complete unit by skidding in any direction without injury when using plates or rails.

h) Tank shields shall be such that no magnetic/fields shall exist outside the tank. If required impermeable shields shall be provided at the coil ends. Tank shield shall not resonate when excited at the natural frequency of the equipment. Bidder may confirm use of tank shields in the schedule of additional information.

i) Suitable guides shall be provided in the tank for positioning the core and coil assembly.

j) Each tank shall be provided with
   (i) Lifting lugs suitable for lifting the equipment complete with oil
   (ii) A minimum of four jacking pads in accessible position at 500 mm height to enable the transformer complete with oil, to be raised or lowered using hydraulic or screw jacks.
   (iii) Suitable haulage holes shall be provided.

k) The transformer should be of bell tank design only. No other design is acceptable.Proper tank shielding shall be done to prevent excessive temperature rise of the joint.

3.1.2 Tank cover:

(a) The tank cover shall be sloped to prevent retention of rainwater and shall not distort when lifted.

(b) At least two adequately sized inspection openings, one at each end of the tank shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. The inspection covers shall be provided with two handles.

(c) The tank covers shall be fitted with pockets at the position of maximum oil temperature of MCR (Maximum Continuous Rating) for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank.

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

(e) All bolted connections shall be fitted with weather proof, hot oil resistant gasket in between, for complete oil tightness. If gasket is compressible metallic stops shall be provided to prevent over-compression.

3.1.3.1 **Axles and Wheels:**

(a)The transformers are to be provided with flanged bi-directional wheels and axles. These shall be so designed as not to deflect excessively to interfere with the movement of the transformer. Wheels shall be provided with suitable bearings, which shall be rust and corrosion resistant. Fittings for lubrication shall also be provided.

(b) Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

(c) The wheels are required to swivel and they shall be arranged so that they can be turned through an angle of 90° when the tank is jacked up to clear of rails. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.

(d) The rail track gauge shall be 5' – 6" (1676 mm) along longer axis as well as along shorter axis. The arrangement should be such that transformer can be installed in any direction i.e. along longer axis or along shorter axis on 2 rails with spacing of 1676 mm.

3.1.4 **Foundation and Anti Earthquake Clamping Device**

3.1.4.1 To prevent transformer movement during earthquake, clamping device shall be provided for fixing transformer to the foundation. The Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangements shall be such that the transformer can be fixed to or unfastened from these bolts as desired. The fixing of the transformers to the foundations shall be designed to withstand seismic, events to the extent that a static co-efficient of 0.3g, applied in the direction of least resistance to that loading will not cause the transformer or clamping devices as well as bolts to be over stressed.

The details of the device used and its adequacy shall be furnished by the contractor.

3.1.5 **Conservator & Oil Preservation System**

3.1.5.1 Main conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture,and shall be fitted with magnetic oil level gauge with low oil level potentialfree contacts. Additionally, prismatic oil level gauge shall also be provided for the full height of the end section of the conservator.

3.1.5.2 OLTC shall have conventional type conservator with magnetic oil level gauge with low oil level potential free contacts and prismatic oil level gauge also.

3.1.5.3 **Conservator tank**

(a) The conservator tank shall be of minimum 8mm thickness and shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100^{o}C. Conservator shall be with volumetric capacity at least 7 ½ percent of a total volume of oil in the main tank of the transformer.

b) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell

(c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

(d) Conservator shall be provided in such a position as not to obstruct the electrical connections to the transformer.

(e) Separate conservator tank/compartment in the main conservator shall be provided for OLTC.

3.1.5.4 **Oil Preservation Equipment**

The requirements of air cell type oil sealing system are given below.

3.1.5.4.1 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth.

3.1.5.4.2 The temperature of oil is likely to rise upto 100^{0}C during operation. As such air cell used shall be suitable for operating continuously at 100^{0}C.

3.1.5.4.3 Air cell of conservator shall be able to withstand the vacuum during installation/maintenance periods. Otherwise provision shall be kept to

isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with the conservator.

3.1.5.4.4 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

3.1.5.5 **Dehydrating Filter Breather**

Conservator shall be fitted with a dehydrating filter breather. It shall be so designed that:

a) Passage of air is through silicagel.
b) Silicagel is isolated from atmosphere by an oil seal.
c) Moisture absorption indicated by a change in colour of the tintedCrystalscan be easily observed from a distance.
d) Breather is mounted not more than 1200 mm above rail top level.
e) To minimise the ingress of moisture following shall be provided.
   i. Three silicagel breathers (of identical size) shall be connected in series for main tank conservator. Each of the breather shall be properly supported. Minimum quantity of silicagel to be 1 kg for every 3500 litre of oil in the tank.
   ii. Two breathers (each of 2.5 litres minimum volume) shall be connected in series for OLTC tank conservator.

3.1.6 **Pressure Relief Device**

Adequate number (Minimum3 Nos.) of pressure relief devices shall be provided at suitable locations. These shall be mounted on an extended pipe section and not directly on the tank top and shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment.The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directlyon the tank. One set of electrically insulated contacts shall be provided for alarm/tripping.. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank. Following routine tests shall be conducted on PRD.

a. Air pressure test
b. Liquid pressure test
c. Leakage test
d. Contact test
e. Dielectric test.

3.1.7 **Buchholz Relay**

A double float/reed type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper/stainless steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

3.1.8 **Temperature Indicators :**

3.1.8.1 **Oil Temperature Indicator (OTI)**

All transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm, trip contact. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Temperature indicator dials shall have linear gradations to clearly read atleast every 2^0C. Accuracy class of OTI shall be ± 1.5% or better.In addition to the above signal transmitter shall be provided for remote indication of oil temperature for recording oil temperature at Substation Automation System.

3.1.8.2 **Winding Temperature Indicator (WTI)**

A device for measuring the hot spot temperature of each winding shall be provided (HV, IV and LV). It shall comprise the following:

i) Temperature sensing element.
ii) Image coil.
iii) Auxiliary CTs, if required to match the image coil, shall be furnished andmounted in the cooler control cabinet.
iv) 150 mm dia local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts; besides that required for control of cooling equipment if any, one for high winding temperature alarm and one for trip.The contacts used for cooler control settings shall have differential operate and reset settings. Temperature indicator dials shall have linear gradations to clearly read at least every 2^0C.
v) Calibration device.
vi) Accuracy class of WTI shall be ± 1.5% or better.
vii) In addition to the above, the following equipment shall be provided for remote indication of winding temperature for each of the winding:
   a) Signal transmitter for each winding
      Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Substation Automation System.
   b) Remote winding temperature indicator
      It shall be suitable for flush mounting on panel. This shall not be repeater dial of local WTI and will operate by signal transmitter.Any special cable required for shielding purpose, for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of Contractor. Only one RWTI with a four point selector switch shall be provided for all the three windings (HV, IV and LV).

3.1.8.3 On line DGA monitoring device shall be provided to detect **eight gases plus nitrogen and moisture content** dissolved in the transformer insulating oil.No carrier/consumable gases shall be required for Online DGA monitor.One Online DGAuniteach shall be provided on each one of the two Auto transformer.The device shall detect any change in quantity of the above gases which may occur due to faults in the transformer or degradation of transformer insulation and oil. The DGA monitoring deviceshall be supplied along with software interface and PC. The online gas analysis shall facilitate user to configure alarm ,sampling rate, offering password protection, access to

interrogate the monitoring of gases locally or remotely and down load for data analysis. The soft ware to produce graphical representation of data giving analytical presentation for diagnosis shall also be provided.The data received from Online DGA monitoring device shall be integrated into Substation Automation System.

The device should have capacity to internally store minimum two years of Data. It should have non volatile memory storage to prevent loss of data.

The device should have following communication facilities:-

(i) Two separate channels for remote communications plus local USB connection and Ethernet connections.

(ii) Communications protocols supported should include IEC61850.

(iii) Connection via RS485, Ethernet,

3.1.8.4 Nitrogen injection fire prevention system:-

Each oil filled transformer shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion which shall use nitrogen as quenching medium. The system shall prevent transformer oil tank explosion and possible fire in case of internal / external cause.

In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc., it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable with time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection.

Activation of the system

Mal-functioning of the Nitrogen injection system could lead to interruption in power supply. The supplier shall ensure that the probabilities of chances of malfunctioning of the Nitrogen injection system are practically zero. To achieve this objective, the supplier shall plan out scheme of activating signals which should not be too complicated to make the system inoperative in case of actual need. The system shall be provided with automatic controls to prevent the explosion of transformers. Besides automatic control, remote electrical push button control at Control box and local manual control in the cubicle shall also be provided. Simultaneous activation of the following electrical-signals shall be used for initiating the system under prevention mode/fire extinguishing mode.

Auto Mode

For prevention:

• Differential relay operation.

• Buchholz relay paralleled with pressure relief valve

Tripping of all circuit breakers (on HV,IV& LV side) associated transformer is the pre- requisite for activation of system.

For extinguishing

• Fire Detector

• Buchholz relay paralleled with pressure relief valve

Tripping of all circuit breakers (on HV,IV& LV side) associated with transformer is the pre-requisite for activation of system.

Manual Mode (Local / Remote)

Tripping of all circuit breakers (on HV,IV& LV side) associated with transformer is the pre-requisite for activation of system.

Manual Mode (Mechanical)

• Tripping of all circuit breakers (on HV,IV& LV side) associated with transformer is the pre-requisite for activation of system.

The system shall be designed to be operated manually in case of failure of power supply to the system.

General description

Nitrogen Injection system should be a dedicated system for each oil filled transformer. It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-10 m away from transformer or placed next to the firewall (if fire fighting wall exists). The FEC shall be connected to the top of transformer oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10% of total volume of oil in transformer tank / or existing oil pit) from its bottom through oil pipes.

The FEC should house a pressurized nitrogen cylinder (s) which is connected to the oil tank of transformer oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay. Cable connections are to be provided from signal box to the control box in the control room, from control box to FEC and from TCIV to signal box. Detectors placed on the top of transformer tank are to be connected in parallel to the signal box by Fire survival cables. Control box is also to be connected to relay panel in control room for receiving system activation signals.

Operation

On receipt of all activating signals, the system shall drain - pre-determined volume of hot oil from the top of tank (i.e. top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

System components

Nitrogen Injection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the system shall deemed to be included in the scope of supply.

MS Storage tank for storage of extracted oil

The MS storage tank of cylindrical shape should be provided for storage of extracted oil. The capacity of tank should be minimum 12% of total oil capacity of transformer.

The MS storage tank should have facility of oil filtration in side the tank. For this 2 No. flanges (one for delivery and the other for suction) should be provided. The suction flange should be connected to the bottom of the tank. The storage tank should be made of 8 mm thick plat. The inner side of the tank shall be painted with 2 coats of heat resistant, oil insoluble, insulating varnish. The outer surface shall be given a primary coat of zinc chromate, second coat of oil & weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resisting light grey paint in accordance with shade No. 631 of IS-5. Adequate size of inspection window should be provided so that tank can be cleaned by manual labour. A vent pipe of adequate diameter shall be provided a breather fitted on it in order to allow breathing of air.

CUBICLE (FEC)

The Cubicle Frame shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS -5). It shall have hugged / hinged split doors fitted with high quality tamper proof lock. The doors, removable covers and panels shall be gasketted all round with neoprene gaskets. The degree of protection shall be IP55. The following items shall be provided in the Cubicle.

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system.Limit switch for pressure switch/sensor
- Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer.
- Panel lighting (CFL Type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil storage tank.
- Space heater.

Control box:

Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.

- System Oil.
- TCIV open.
- Oil drain valve closed.
- Gas inlet valve closed
- TCIV closed
- Detector trip
- Buchholz relay trip
- Oil drain valve open
- Extinction in progress
- Cylinder pressure low
- Differential relay trip
- PRV trip
- Transformer trip
- System out of service
- Fault in cable connecting fault detector
- Fault in cable connecting differential relay
- Fault in cable connecting Buchholz relay
- Fault in cable connecting PRV
- Fault in cable connecting transformer trip
- Fault in cable connecting TCIV
- Auto / Manual / Off
- Extinction release on / off
- Lamp test
- Visual / Audio alarm for AC supply fail
- Visual / Audio alarm for DC supply fail
- Nitrogen cylinder pressure indication.

- Fire in Transformer.
- Oil drain started.
- Conservator oil isolation valve closed.
- Nitrogen injection started.

As far as possible the control box should be such devised that all the transformers and or group thereof should be controlled from single spot.

The control box shall have one IEC 61850 compliant IED (BCU) of GE/Alstom/ ABB/ Siemens/SEL make, wherein operation of all the major components of NIFPS shall be logged in as time tagged events for analysis and evaluation of operation of NIFPS.It shall have 20 % spare input and output contacts over what has been utilised in the scheme. This IED (BCU) shall have minimum 20 numbers of freely configurable input and output contacts. The BCU shall also have Ethernet/RJ ports for achieving redundancy in Ethernet switch connection. The IED (BCU) shall have self monitoring feature and shall have event logger, disturbance Recorder and on initiation of event, it shall automatically be downloaded at the workstation of substation.The IED (BCU) shall have IRIG –B port for GPS time synchronizing.

Transformer Conservator Isolation Valve:

Transformer conservator isolation valve (TCIV) to be fitted in the conservator pipe line, between conservator and buchholz relay which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator.The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer.Locking plates shall be provided for pad locking.

Detectors:

The system shall be complete with minimum 24 numbers of detectors (quartz bulb) fitted on the top cover of the transformer oil tank. The bulbs should be provided to ensure monitoring of all the HV, IV, LV & neutral bushings. Redundancy of detectors should be ensured & clearly brought in the drawing submitted for approval.Minimum 25 numbers of fire detectors shall be provided.

Signal box:

It shall be mounted away from transformer main tank, preferably near the transformer marshalling box, for terminating cable connections from TCIV & detectors and for further connection to the control box. The degree of protection shall be IP55.

Cables:

Fire survival cables (capable to withstand 750º C.) of 4 core x 1.5 sq. mm size for connection of detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.

Fire Retardant Low Smoke (FRLS) cable of adequate size shall be used for connection of signal box / marshalling box near transformer and FEC mounted near transformer with control box mounted in control room. Fire Retardant Low Smoke (FRLS) cable of 4 core x 1.5 sq. mm size shall be used for connection between control box to DC & AC supply source, FEC to AC supply source, signal box / marshalling box to transformer conservator isolation valve connection on transformer. Separate cables for AC supply & DC supply shall be used.

Pipes:

Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system.

Other items to be supplied:

(a) Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.
(b) Flanges between Buchholz relay and conservator tank for fixing TCIV.
(c) Detector brackets on transformer tank top cover.
(d) Spare potential free contacts activating the system i.e. in differential relay, Bucholz relay. Pressure Relief Device, Circuit breaker of transformer.
(e) Pipe connections between transformer and FEC and between FEC and oil pit required for collecting top oil.
(f) Cabling for detectors mounted on transformer top cover.
(g) Inter cabling between signal box, control box and FEC.
(h) Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
(i) Supports, signal box etc. which are to be painted with enameled paint.
(j) Any other item required for satisfactory operation of system.

Power supply

For Control Box 220 V DC
For FEC Auxiliary 230 V AC
Spares for three (3) years Operation & Maintenance

The bidder apart from the below mentioned spares shall submit a list of recommendation spares for three years trouble free operation of the equipments and also furnish unit rates. The owners will scrutinize the said list and decide on the items on spares to be ordered and the quantities. These spares shall be supplied by the bidder before end of guarantee period. The owner reserves right to order the spares with twelve (12) months from the date of order for main equipments and the rate shall be kept valid till this date. The prices of these spares shall not be considered for evaluation of the bid.

Mandatory Spares

Cylinder filled with Nitrogen of required Capacity per transformer - 1 No.
Detectors per transformer - 3 no.
Regulator assembly per sub-station 1 No.

Modification on the transformer

No modification on the transformer shall be allowed which affects its performance (i.e. efficiency, losses, heat dissipation ability etc.) safety, life etc. or it's any other useful parameter. This requirement shall be paramount importance and shall form the essence of the contract. However, in any case, performance of transformer should not be affected in any manner by having Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPES) and the Bidder / Sub-vendor shall give an undertaking to this effect. All pipes should be washed / rinsed with transformer oil. If any damage is done to the transformer and / or any connected equipment during installation & commissioning full recovery therefore shall be effected from the Bidder /Sub-vendor, of NIFPES system.

It shall be solely the responsibility of bidder / Sub-vendor to install, carry out pre-commissioning tests & commission NIFPES at the mentioned Sub-Station in this specification, to the entire satisfaction of the CSPTCL.

Interlocks:

It shall be ensured that once the NIFPES gets activated manually or in automode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PRV shall get closed only if all the connected breakers are open.

Tests:

Bidder has to carry out the type test as per relevant IS/IEC. Specifically IP 55 on FEC or have to produce the report from NABL approved Lab. Reports of all routine test conducted as per relevant IS/IEC standards in respect of various bought out items including test reports for degree of protection for FEC / control box / signal box shall be submitted by the supplier.

The supplier shall demonstrate all the functional test associated with the following as Factory Acceptance Tests:

• FEC, Control Box
• Fire Detector
• Transformer Conservator Isolation Valve

The performance test of the complete system shall be carried out after erection of the system with transformer at site. Detailed layout drawings, equipment drawing along with 4 sets of Operation and Maintenance manual along with soft copies (In CDs) shall be submitted by the supplier along with the consignment. The guaranteed and other technical particulars for the offered system are indicated in Section - "Guaranteed and Other Technical Particulars". Any other particulars considered necessary in addition to those listed in that Section may be furnished by the Bidder.

The system should have provision for storage of sufficient volume of nitrogen for fire prevention/extinguishing. The control and monitoring of the device shall be integrated into Substation Automation System.

3.1.9 **Earthing Terminals**

3.1.9.1 Two (2) earthing pads (each complete with four (4) nos. holes, M 10 bolts, plain and spring washers) suitable for connection to 75 x 12 mm galvanised steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

3.1.9.2 Two earthing terminals suitable for connection to 75 x 12 mm galvanised steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately.

3.2 **Core**

3.2.1 The core shall be constructed from high grade, non-ageing, cold rolled, super grain oriented, silicon steel laminations (Hi B).The core material shall be of prime quality. Bidder will offer the core for inspection and approval by the purchaser during manufacturing stage.The bidder call notice should be accompanied with the following documents as applicable as a proof towards use of prime grade material.

a) Invoice of the supplier
b) Mill's test certificate
c) Packing list
d) Bill of loading
e) Bill of entry certificate by customs.

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

3.2.3 **CORE EARTHING ARRANGEMENT**

The manufacturer should bring out leads from core ,end frame and tank to top of the transformer through insulated bushings. It may be noted that internal earthing of any nature from core and frame should not be provided. Earthing at site shall be done by taking connections from top of the tank. The insulation of core to bolts

and core to clamp plates shall be able to withstand a voltage of 2 KV (rms) for 1 minute.

3.2.4 Core and winding shall be capable of withstanding the shock duringtransport, installation and service. Adequate provision shall be made toprevent movement of core and winding relative to tank during theseconditions.

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

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

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

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

3.3 Windings

3.3.1 The Contractor shall ensure that windings of all 400 kV class transformers are made in dust proof and conditioned atmosphere.

3.3.2 The conductors shall be of electrolytic grade copper free from scales andburrs.

3.3.3 The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

3.3.4 Coil assembly and insulating spacers shall be so arranged as to ensurefree circulation of oil and to reduce the hot spot of the winding.

3.3.5 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.

3.3.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalise the distribution of currents and temperature along the winding.

3.4 Insulating Oil

The insulating oil shall conform to all parameters specified, while tested at supplier's premises. No inhibitors shall be used in oil. The contractor shall furnish test certificates from the supplier against their acceptance norms as mentioned below, prior to despatch of oil from refinery to site. EHV Grade I oil shall be used. The quality of the oil supplied with transformer shall conform to the oil parameters specified in this clause. No inhibitors shall be used in the oil. The oil samples will be drawn as follows:

i) Prior to filling
ii) Before and after heat run test
i) Before energizing.

All tests as per IS: 335 shall be conducted on all samples.

a) The insulating oil shall be subjected to testing in the oil manufacturer’s works before supply in the presence of the representative of the transformer manufacturer.
b) Sufficient quantity of oil necessary for first filling of all tanks, coolers and radiator at the proper level along with 10% extra oil by weight for topping up shall be supplied in non-returnable containers suitable for outdoor storage.
c) Power Transformers shall be supplied with oil.
d) The parameter of the EHV Grade I transformer oil should conform to the values as given in schedule.The bidder shall warrant that characteristic of oil furnished shall comply with the requirements specified in IS-335, 1993 (Latest

Revision) with latest amendment/revision or better as specified and shall be suitable for EHV grade Transformer.

3.5 Terminal Arrangements

3.5.1 Bushings

Oil impregnated paper insulated condenser type bushing shall be provided for 420 KV, 245 KVand 72.5 KV class with the following specifications.

Oil Filled condenser type bushing shall be provided with at least the following fittings:

(a) Oil level gauge.
(b) Oil filling plug and drain valve if not hermetically sealed.
(c) Tap for capacitance and tan delta test.

These bushings shall be outdoor immersed self-contained draw-through lead or rod type, with oil filling. The active part of bushing shall consist of a condenser body built up around a centre tube using high quality kraft insulating paper. The paper craft shall be wound over the centre tube with pure aluminium foils inserted at pre designed locations to get optimum combination of external flashover and internal puncture strength.

The condenser body shall be enclosed in weather resistant housing consisting of a top expansion chamber, upper porcelain, a welded flange – ground sleeve assembly, lower porcelain and a bottom cap. The annular space between the condenser body and the housing shall be filled with Grade-I transformer oil. An assembly located in the top housing hold all the gasket and O ring between porcelain and metal parts thereby completely sealing the bushing. An oil sight window shall be provided on the expansion chamber for observing the oil level. The space in the expansion chamber above oil shall be filled with dry Nitrogen gas.

Brown glazed porcelain insulators of high strength are used as air end and oil end insulators. Air end porcelain shall normally be provided with total nominal creepage length 25 mm/KV of the rated voltage unless otherwise specified. Oil end porcelain shall be cone shaped without shed. Air end porcelain shall be provided with long and short sheds(aerodynamic shed profile).Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Bushings shall be manufactured from high quality porcelain. Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

Bushings hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used. The hollow column insulator shall be of reputed make and subject to the approval of CSPTCL. 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.

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.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Galvanized bolts and nuts shall be used as fasteners. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

After assembly, the bushings shall be dried out at a very high vacuum pressure. These shall then be impregnated with transformer oil. Oil impregnation shall be carried out under pressure. The oil level in bushing shall then be adjusted and the bushings shall be sealed subsequently.

For the bushings of rated voltage 420 KV &245 KV, stress relieving shield shall be provided on the lower cap. The shield shall consist of an aluminium shroud insulated in kraft paper and press board moulding. The maximum stress in oil and the surface of these shield insulation must be limited to those values normal for insulated conductors and similar components in the same transformer.

The draw lead or draw rod connecting the top terminal will be supplied along with bushing. The complete joint connector shall be provided with the draw lead and the free connector shall be suitable for brazing the lead from the connecting improvement in the case of draw rod the free end shall form the connector. For the air side connection, rod type terminal shall be provided.

The bushing shall be provided with an insulation test tap suitable for measuring bushing power factor (dissipation factor) and capacitance by ungrounded specimen test method. The cover of this tap should be removed from the tap attachment only for testing purpose. Normally the tap shall be grounded through the cover and the bushing shall not be operated with cover remove.

Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.Bushings of identical rating shall be interchangeable.Bushing turrets shall be provided with vent pipes, to route any gascollection through the Buchholz relay. Suitable insulating cap (preferably of porcelain) shall be provided on the terminal of Bushing of tertiary winding to avoid accidental external short circuit. Tertiary Bushing shall preferably be mounted at the same level as that of HV and IV bushings.

Tests:

Bushings shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099, IEC 60137, IS: 2544 & IS: 5621. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020. The following type test reports of the offered bushings shall have to be submitted for approval.

a) Wet power frequency voltage withstand test.
b) Dry lighting impulse voltage withstand test.
c) Dry or wet switching impulse voltage withstand test.
d) Thermal stability test.
e) Temperature rise test.
f) Thermal short time current withstand test.
g) Dynamic current withstand test.
h) Cantilever load withstand test.
i) Tightness test on liquid filled and liquid insulated bushings.

The dielectric tan delta value shall not be more than 0.005.The insulation resistance of the bushing shall not be less than 20 G ohm. The partial discharge of the bushing shall not be more than 10 pC.

35.1.2**Terminal connectors:**

a) Terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been

successfully type tested strictly as per IS: 5561.The connector offered should be in line with the approved drawing.

b) Connectors shall be in two parts. The Bushing stud part shall be of copper and conductor part shall be of Aluminium. The copper part shall be electrolytic grade copper forged and silver plated/tinned for 10 Minorca's.

c) No part of a clamp shall be less than 15mm thick.Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

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

e) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.The terminal connector of should be suitable for twin Moose conductor

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The drawing of terminal connector offered shall have to be got approved by CSPTCL

ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

iii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

iv) Flexible connectors shall be made from tinned copper sheets.

3.6 Bushing Current Transformer:

a) The transformer shall be provided with bushing CTs on HV, IV & Neutral for the purpose of REF protection. The ratio and accuracy class shall be as specified.. The bushing CTs will be in addition to the WTI CTs required on HV, IV & LV.

b) Current transformers shall comply with IS: 2705.

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

d) All secondary leads shall be brought to a terminal box near each bushing. These terminals shall be wired out to cooler Control Cabinet using separate cables for each core.

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

3.6.1 Terminal Marking

The terminal marking and their physical position shall be as per IS: 2026.

3.7 Neutral Earthing Arrangement

The neutral terminal of auto transformer shall be brought to the ground level by a tinned copper grounding bar (min. size 80 mmx 10 mm), supported from the tank by using porcelain insulators of 36 KV rating. The end of the tinned copper bar

shall be brought to the bottom of the tank, at a convenient point, for making bolted connection to two (2) numbersMoose conductor connected to grounding mat.
Suitable flexible copper strip connection of adequate size shall be provided for connecting to Neutral Bushing terminals to avoid terminal load on the Bushings.

3.8 Cooling Equipment and its Control

3.8.1 Cooling Equipment

3.8.1.1 The cooler shall be designed using 2 x 50% radiator banks. Design of cooling system shall satisfy the performance requirements.

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

3.8.1.3 Required number of standby fans of approximately 20% capacity shall also be provided with each radiator bank.

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

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

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

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

3.8.1.8 The cooler and its accessories shall preferably be hot dip galvanised or corrosion resistant paint should be applied to it.

3.8.1.9 Expansion joint shall be provided, one each on top and bottom cooler pipe connections.

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

3.8.2 Cooling Equipment Control (ONAN/ONAF/OFAF COOLING)

3.8.2.1 Automatic operation control of fans/pumps shall be provided (with temperature change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic change over of cooler control from ONAN to ONAF and then to OFAF. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

3.8.2.2 Suitable manual control facility for cooler fans and oil pumps shall be provided.

3.8.2.3 The changeover to standby oil pump in case of failure of service oil pumpshall be automatic.

3.8.2.4 Selector switches and push buttons, shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans and pump manually.

3.8.3 **Indicating Devices**

Following lamp indications shall be provided in cooler control cabinet :

a) Control Supply failure.
b) Cooling fan failure for each bank.
c) Cooling pump failure for each pump.
d) No oil flow/reverse oil flow for pumps.
e) Common thermal overload trip.

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet .The Control and monitoring of the Cooler Control system shall have to be integrated in Substation Automation System. It shall have the provision of control and monitoring of cooler individual fan/pump also.

3.8.4 **Valves**

3.8.4.1 All valves upto and including 100 mm shall be of gun metal or of cast steel/cast iron. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.

3.8.4.2 Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.

3.8.4.3 Each valve shall be provided with the indicator to show clearly the position
of the valve.

3.8.4.4 All valves flanges shall have machined faces.

3.8.4.5 All valves in oil line shall be suitable for continuous operation with transformer oil at 1000C.

3.8.4.6 The oil sampling point for main tank shall have two identical valves to be put in series .Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.

3.8.4.7 A valve or other suitable means shall be provided to fix the on line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalised during detail engineering stage.

3.8.4.8 Suitable valves shall be provided to take sample of oil from the OLTC chamber during operation of the transformer.

3.8.4.9 After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to IS:2932 and of a shade (preferably red or yellow) distinct and different from that of main tank surface. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to IS:2074 followed by two coats of fully glossy finishing paint.

3.8.4.10 All hardware used shall be cadmium plated/electro galvanised.

3.9 **Tap Changing Equipment**

3.9.1 Tap Change Switch General Requirement :

OLTC shall be motor operated for local as well as remote operation. An external handle shall be provided for local manual operation. This handle shall be suitable for operation by a man standing at ground level.

3.9.2 **<u>On Load Tap Changing Gear (OLTC)</u>**

3.9.2.1 Each Autotransformershall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load and without producing phase displacement.

3.9.2.2 The requirements of on load tap changing equipment are given here below :

a) The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer.

b) The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

c) The Bidder shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.

d) The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with a oil surge relay the outlet of which shall be connected to a separate conservator tank.

e) The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of ancillary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment.

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

g) Local OLTC control cabinet shall be mounted on the tank in accessible position. It should be adequately ventilated and provided with anti-condensation metal clad heaters. All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.

h) Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command. Subsequent tap changes shall be initiated only by a new or repeat command.

i) On load tap changer shall be equipped with a time delayed INCOMPLETE STEP alarm consisting of a normally open contact which closes, if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.

j) The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer .The Bidder shall also provide a set of instruments for

tap position indication in the control room. Complete mounting details shall be included in the approved diagram.

k) Transformer on load tap shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the Substation Automation System.

l) Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition.

m) Limit switches may be connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated.

n) Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, fuses etc. shall be mounted in the local OLTC control cabinet and shall be clearly marked for the purpose of identification.

o) A permanently legible lubrication chart if required, shall be fitted within the local OLTC control cabinet.

p) Any 'DROP DOWN' tanks associated with the tap changingapparatus shall be fitted with guide rod to control the movements
during lifting or lowering.

q) A five digit counter shall be fitted to the tap changing equipment to indicate the number of operations completed.

r) All relays and operating devices shall operate correctly at any voltage between the limits specified.

s) It shall not be possible to operate the electric drive when the manual operating gear is in use.

t) It shall not be possible for any two controls to be in operation at the same time.

u) The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position indication.

v) Operation from the local or remote control switch shall cause one tap movement only until the control switch is returned to the off position between successive operation.

w) All electrical control switches and the local operating gear shall be clearly labelled in a suitable manner to indicate the direction of tap changing.

x) Transfer of source in the event of failure of one AC supply shall not affect the tap changer.

3.9.3 OLTC Control of Three Phase AutoTransformers

Each three phase transformershall be suitable for local and remote control. The control feature shall provide the following :

3.9.3.1 Local Electrical Control

(a) 'Local-remote' selector switch mounted in the local OLTC control cabinet shall switch control of all load tap changers as followings:

i) When the selector switch is in 'local' position, it shall be possible to operate the 'raise-lower' control switches specified in clause 3.9.3.1(b)

below. Remote control of the raise-lower functions shall be prevented.

ii) When the selector switch is in 'remote' position the local OLTC control cabinet mounted 'raise-lower' switch specified in clause 3.9.3.1(b) below shall be in-operative. Remote control of the raise/lower function shall be possible from the remote control panel. The 'local-remote' selector switch shall have at least twospare contacts per position which are closed in that position but open in the other position.

(b) A 'raise-lower' control switch/push button shall be provided in the local OLTC control cabinet. This switch shall be operative only when 'local remote' selector switch is in 'local' position.

(c) An OFF-ON tap changer control switch shall be provided in the local OLTC control cabinet of the transformer. The tap changer shall be in-operative in the OFF position. Also the OFF-ON switch shall have atleast one spare contact per position which is closed in that position but open in the other position.

(d) There shall be a provision of Emergency trip of tap operation.

3.9.3.2 Manual Control

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with the following :

a) Mechanical tap position indicator which shall be clearly visible from near the transformer.

b) A mechanical operation counter.

c) Mechanical stops to prevent over-cranking of the mechanism beyondtheextreme tap positions.

d) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be labelled to show the direction of operation for raising the HV terminal voltage and vice-versa.

3.9.3.3 Remote Electrical Group Control

The OLTC control scheme offered shall have provision of remote electrical group control during the parallel operation of transformer. This is in addition to independent control of OLTC .**There shall be provision of Remote Tap Change of the transformer through Substation Automation System.A separate screen on SAS shall be provided with all the interlocks and control features implemented.**

i) A four position selector switch having Master, Follower, Independent and Off position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in either Master, Follower or Independent mode.

ii) Out of step relays with timer contacts shall also be provided to give alarm and indication in case tap position in all the transformers under group control are not in same position.

iii) Master Position

If the selector switch is in Master position, it shall be possible to control the OLTC units in the follower mode by operating the controls of the master unit. Independent operation of the units under Follower mode

shall have to be prevented. However the units under independent mode will be controlled independently.

iv) Follower Position
If the selector switch is in Follower mode, control of OLTC shall be possible only from panel of the Master unit.

v) Independent Position
In this position of Selector Switch, Control of OLTC of individual unit shall only be possible.

vi) There shall be a provision of emergency Trip of the tap change operation.

3.9.5 The control circuits shall comply with following conditions:

3.9.5.1 An interlock to cut off electrical control automatically upon recourse being taken to the manual control in emergency.

3.9.5.2 Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.

3.9.5.3 "Step-by-Step" operation ensuring only one tap change from each tap changing impulse and a lock-out of the mechanism if the control switch (or push button) remains in the "operate" position.

3.9.5.4 An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

3.9.5.5 An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.

3.9.5.6 Tap change in progress indication shall be provided by means of an indicating lamp at the Employer's control panel. Necessary contacts for this and for remote tap position indicator at Employer's control panel shall be provided by the Bidder.

3.9.5.7 Protective apparatus, considered essential by the Bidder according to specialities of the gear.

3.10 Local OLTC Control Cabinet, Cooler Control Cabinet and Remote Tap Changer Control Panel

3.10.1 Each single/three phase transformer unit shall be provided with local OLTC control cabinet, cooler control cabinet and RTCC panel.

3.10.2 The sheet steel used for cooler control cabinet and local OLTC control cabinet shall be at least 2.5 mm thick. The degree of protection shall be IP:55 in accordance with IS:13947. The gaskets used shall be of neoprene rubber. All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof. All the control cabinets shall be provided with suitable lifting arrangement.

3.10.3 A space heater, and cubicle lighting with ON-OFF switch shall be provided in each panel.

3.10.4 Necessary shorting of terminals shall be done at the cooler control cabinet, local OLTC cabinet and remote OLTC panel. All the CT secondary terminals in the cooler control cabinet shall have provision for short circuiting to avoid CT open circuit while it is not in use.

3.10.5 **Cooler Control Cabinet**

3.10.5.1 The cooler control cabinet shall have all necessary devices meant for cooler control and local temp. indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the cooler control cabinet. All the necessary terminals for remote connection to Employer's panel shall be wired upto the cooler control cabinet. **The facilities of Cooler control**

panel shall be integrated in SAS suitably to facilitate control and monitoring of the same. An independent BCU shall be provided in Cooler control panel for this purpose.

3.10.5.2 The cooler control cabinet shall have two (2) sections. One section shall have the control equipment exclusively meant for cooler control. The other section shall house the temperature indicators, aux. CTs and the terminal boards meant for termination of various alarm and trip contacts as well as various bushing CT secondary. The Minimum size of the Cooler Control panel shall be 2200 mm x 1600mm x 800mm. Alternatively the two sections may be provided as two separate panels depending on the standard practice of the Bidder.

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

3.10.6 **Local OLTC Control Cabinet :** The Local OLTC control cabinet shall house all necessary devices meant for OLTC control and indication. It shall be complete with the following:

i) A circuit breaker/contactor with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor.
ii) Cubicle light with door switch.
iii) Space heaters to prevent condensation of moisture.
iv) Padlocking arrangement for hinged door of cabinet.
v) Cable terminal glands for power and control cables to the OLTC gear.

3.10.7. **Remote Tap Changer Control Panel.**

The Contractor shall supply a Remote Tap Changer Control (RTCC) panel suitable for remote operation of On load tap changing gear.**The facilities of RTCC shall be integrated in SAS suitably to enable tap change through station HMI with all interlocks and security implemented.An independent BCU shall be provided in RTCC panel for this purpose.**

The auxiliary devices for remote electrical control of the OLTC and Cooler shall be housed in a separate panel to be placed in the Control room. The panel shall be made of sheet steel of not less than 14 SWG and it shall be duly finished with stove enamel paint. The size and of the control cubicle to be supplied by the bidder shall be 750 mm depth and 2312 mm height and colour opaline green shade no. 275 of B.S.271-C: 1948, respectively. The width of the cubicle to be as per manufacturer's practice. Control and signal devices required to be mounted in the RTCC Panel shall comprise of the following.

i. Local - Remote selector switch for OLTC .
ii. Actuating switch/push; button for electrical raise/lower control.
iii. Remote tap position indicator with tap number and corresponding; rated voltage marked on the; instrument. The tap position indicators shall be digital type.
iv. A four position selector switch having master follower, independent and off position.
v. Repeater dial of transformer winding temperature indicator.
vi. Name plate for each component.
vii. Initiating devices and contacts for alarm as well as for indications for discordance in the tap changer if any of the parallel operating transformer.
viii. Cubicle lamp actuated by door, switch, space heater power sockets etc. shall be provided inside RTCC panel.
ix. Annunciator (facia type) Scheme complete with accessories for the following:
    (a) Tap changer out of step.
    (b) Tap changer motor trip.

(c) Failure of AC supply to the OLTC local control Kiosk.
(d) Fan failure of each group.
(e) Control supplies failure main and standby.
(f) Cooler supply failure for each supply.
(g) Two spare windows
(h) OLTC at extreme positions i.e. lowest or highest tap.

x. **Signal lamps for:**
(i) Fan 'ON' for each group.
(ii) Standby fan 'ON' for each group.
(iii) Cooling system on manual.
(iv) Cooling system on automatic control.
(v) 415 volts cooler supply auto change over.
(vi) Healthy supply to control gear.
(vii) Tap change in progress.

xi. Emergency stop push button will be provided in local control cubicle as well as on remote tap changer control cubicle panel.

xii. 3 No. digital volt meter of 0.5 Accuracy Class (1 for HV,IV& LV) with selector switch should be provided. HRC cartridge fuse shall be provided for HV and IV PT secondary voltage.

xiii. One No. Ammeter of 0.5 accuracy class for delta winding circulating current (digital)

xiv. One Number BCU/IED

The RTCC panel shall house actuating switch for electrical raise/lower control, tap position indicator, signal lamps for "Tap change in progress" and "Tap changer out of step", and all other auxiliary devices for remote electrical control of the OLTC. For tap position indicator, the dual output type OLTC transducer shall be rovided in the RTCC panel. The one of the output of this transducer shall be used for local indication of tap position in RTCC panel and other output (0-10 mA or 4-20 mA) shall be used for RTUs.

3.11 **Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit**

3.11.1 Two auxiliary power supplies, 415 volt (+)10%(-)20%, three phase four (4) wire shall be provided at cooler control cabinet for OLTC and cooler control and power circuit.

3.11.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the cooler control cabinet for on load tap changer control and cooler circuits.

Design features of the transfer switch shall include the following:

a) Provision for the selection of one of the feeder as normal source and other as standby.
b) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.
c) Indication to be provided at cooler control cabinet for failure of normal source and for transfer to standby source and also for failure to transfer.
d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
e) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

3.11.3 Power Supply for OLTC Circuits

a) AC feeder shall be brought to the local OLTC control cabinet by the Contractor after suitable selection at cooler control cabinet for which

description is given in 3.11.2 above, for control power circuit of OLTC.

b) The Contractor shall derive AC power for OLTC control circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformers. If the control circuit is operated by DC supply, then suitable main and standby converters shall be provided by the Contractor to be operated from AC power source.

3.11.4 **Power Supply for Cooler Circuits**

3.11.4.1 Control and power supplies are to be given for Cooler circuits after the selection as mentioned above.

3.11.4.2 The Contractor shall derive AC power for Cooler Control Circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformer. If the control circuit is operated by DC supply then suitable main and standby convertors shall be provided by the Contractor, to be operated from AC power source.

3.11.5 Necessary isolating switches and HRC fuses shall be provided at suitable points as per Employer's approved scheme.

4 **Fittings**

4.1 The following fittings shall be provided with each three phase transformer covered in this specification :

4.1.1 Conservator for main tank with oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating breather..

4.1.2 Conservator for OLTC with drain valve, oil surge Relay, filling hole withcap, prismatic oil level gauge and silicagel breather.

4.1.3 Oil preservation equipment.

4.1.4 Pressure relief devices with alarm/trip contacts.

4.1.5 Buchholz relay double float/reed type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.

4.1.6 Air release plug.

4.1.7 Inspection openings and covers.

4.1.8 Bushing with metal parts and gaskets to suit the terminationarrangement.

4.1.9 Winding temperature indicators for local and remote mounting. One remote winding temperature indicator with a four point selector switch shall be provided for the three windings for three phase unit to have selection of any of the three windings.

4.1.10 Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes andcore and winding lifting lugs.

4.1.11 Protected type mercury or alcohol in glass thermometer.

4.1.12 Bottom and top filter valves with threaded male adaptors, bottomsampling valve and drain valve.

4.1.13 Rating and diagram plates on transformers and auxiliary apparatus.

4.1.14 Flanged bi-directional wheels/Trolley for movement

4.1.15 Cooler control cabinet.

4.1.16 On load tap changing gear.

4.1.17 Cooling equipment.

4.1.18 Bushing current transformers.

4.1.19 Oil flow indicator.

4.1.20 Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

4.1.21 Terminal marking plates.
4.1.22 Valves schedule plates.
4.2 The fittings listed above are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

5 **Inspection and Testing**

The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment.

5.1 **Inspection**

5.1.1 **Tank and Conservator**

5.1.1.1 Certification of chemical analysis and material tests of plates.
5.1.1.2 Check for flatness.
5.1.1.3 Electrical interconnection of top and bottom by braided tinned copper flexible.
5.1.1.4 Welder's qualification and weld procedure.
5.1.1.5 Testing of electrodes for quality of base materials and coatings.
5.1.1.6 Inspection of major weld preparation.
5.1.1.7 Crack detection of major strength weld seams by dye penetration test.
5.1.1.8 Measurement of film thickness of :
- i) Oil insoluble varnish.
- ii) Zinc chromate paint.
- iii) Finished coat.

5.1.1.9 Check correct dimensions between wheels, demonstrate turning ofwheels through 900C and further dimensional check.
5.1.1.10 Check for physical properties of materials for lifting lugs, jacking pads, etc. All load bearing welds including lifting lug welds shall besubjected to NDT.
5.1.1.11 Leakage test of the conservator.
5.1.1.12 Certification of all test results.

5.1.2 **Core**

5.1.2.1 Sample testing of core materials for checking specific loss,bendproperties, magnetisation characteristics and thickness.
5.1.2.2 Check on the quality of varnish if used on the stampings :
- i) Measurement of thickness and hardness of varnish on stampings.
- ii) Solvent resistance test to check that varnish does not react in hot oil.
- iii) Check over all quality of varnish by sampling to ensure uniform shining colour, no bare spots, no over burnt varnish layer and no bubbleson varnished surface.

5.1.2.3 Check on the amount of burrs.
5.1.2.4 Bow check on stampings.
5.1.2.5 Check for the overlapping of stampings. Corners of the sheet are to bepart.
5.1.2.6 Visual and dimensional check during assembly stage.
5.1.2.7 Check for inter laminar insulation between core sectors before and afterpressing.
5.1.2.8 Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.
5.1.2.9 Visual and dimensional checks for straightness and roundness of core,thickness of limbs and suitability of clamps.
5.1.2.10 High voltage test (2 kV for one minute) between core and clamps.
5.1.2.11 Certification of all test results.

5.1.3.1 Insulation Material

Sample check for physical properties of materials.Check for dielectric strength.Visual and dimensional checks.Check for the reaction of hot oil on insulating material.Dimension stability test at high temperature for insulating Material.Tracking resistance test on insulating material Certification of all test results.

5.1.3.2 Winding

Sample check on winding conductor for mechanical properties and electrical conductivity.

Visual and dimensional checks on conductor for scratches, dent marks etc.

Sample check on insulating paper for pH value, bursting strength and electric strength.

Check for the reaction of hot oil on insulating paper.

Check for the bonding of the insulating paper with conductor.

Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

Check for absence of short circuit between parallel strands. Check for brazed joints wherever applicable.

Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.

Conductor enamel test for checking of cracks, leakage and pin holes. Conductor flexibility test Heat shrink test for enamelled wire.

5.1.3.3 <u>Certification of all test results</u>.

Checks Before Drying Process

Check condition of insulation on the conductor and between the windings.

Check insulation distance between high voltage connections, cables and earth and other live parts.

Check insulating distances between low voltage connections and earth and other parts.

Insulation of core shall be tested at 2 kV/minute between core to bolts and core to clamp plates.

Check for proper cleanliness and absence of dust etc. Certification of all test results.

5..1.3.4 Checks During Drying Process

Measurement and recording of temperature, vacuum and drying time during vacuum treatment.

Check for completeness of drying by periodic monitoring of IR and Tan delta.

Certification of all test results.

5.1.3.5 Assembled Transformer

Check completed transformer against approved outline drawings, provision for all fittings, finish level etc.Test to check effective shielding of the tank. Jacking test with oil on all the assembled transformers. Dye penetration test shall be carried out after the jacking test.

5.1.4 Bought Out Items

The makes of all major bought out items shall be as per the List of Vendors given in this tender document.

The Contractor shall also prepare a comprehensive inspection and testing programme for all bought out/sub-contracted items and shall submit the same to the Employer for approval. Such programme shall include the following components:

a) Buchholz Relay.

b) Axles and wheels.
c) Winding temperature indicators for local and remote mounting.
d) Oil temperature indicators.
e) Bushings.
f) Bushing current transformers.
g) Cooler control cabinet.
h) Cooling equipment.
i) Oil pumps.
j) Fans/Air Blowers
k) Tap change gear.
l) Terminal connectors.

The above list is not exhaustive and the Contractor shall also include other required bought out items in his programme.

5.2 **Factory Tests**

5.2.1 Routine TestsTests:

i) The type test reports of the transformer (as per latest version of IS: 2026) of offered or higher rating conducted at Govt. / Govt. approved laboratory or witnessed by Govt. / Govt. approved laboratory representative should be submitted. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020
ii) Copies of all routine test reports as per latest version of IS:2026 on offered or higher rating transformer conducted within validity period as on due date of opening should also be submitted with the bid.
iii) All routine and additional routine tests shall be carried out on each transformer. The type and special tests mentioned in clause 6.2 shall be carried out on one unit out of the lot. All routine & type tests shall be witnessed by representative of CSPTCL & ERDA/CPRI or any other agency authorized by CSPTCL.
iv) The charges for conducting each type test and special tests shall be indicated separately in the relevant schedule.

Routine tests:-

All standard routine tests in accordance with IS: 2026 (with latest amendment), with dielectric tests as per IS:2026 part-III (with latest amendment) shall be carried out on each transformer. Further some additional routine tests shall also be carried out on each unit.

The list of routine and additional routine tests shall be carried out on each unit according to the methods specified in IS:2026 (Part-I):2011 and IS:2026 (Part-III):2009. The details of the tests to be carried out are as given here under:

Sl.	Particulars
(A) Routine tests:	
1	Measurement of winding resistance at all taps
2	Measurement of voltage ratio at all taps and check of phase displacement
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss
4	No load loss and current (before & after HV & TR Routine Tests) at 90%,

	100%,105 % and 110% of rated voltage with 3W, 3A, 3V meters methods.
5	Measurement of Insulation resistance
6	Dielectric routine tests as per IS:2026 (Part-III) i.e. a) lightning impulse tests on all phases of HV/IV/LV windings b) short duration induced AC withstand voltage tests c) separate source AC withstand voltage tests
7	Tests on load tap changers
(B) Addl. Routine Tests:	
1	Dimensional checks as per approved drawing & specification
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works
3	Polarisation index – IR value for 15 sec, 60 sec & 600 sec duration shall be recorded and PI for 600/60 sec and DAR i.e. ratio of IR values of 60/15 seconds shall be recorded. The PI value (600/60 sec) should be >=2 and DAR value (60/15 sec) should be >=1.3. These values should be recorded both before and after HV tests.
4	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.
5	Capacitance and tan delta measurement to determine capacitance between winding and earth. This test should be carried out before and after series of dielectric tests.
6	Tan delta & capacitance Test on bushings (Before and after HV tests)
7	**Checking of recording of IR values**
	(a) Between core & coil frame
	(b) Between core & tank
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
8	Magnetic balance test at normal and extreme taps (Before and after HV tests)
	Magnetising Current Tests at normal and extreme taps on all three windings with LT voltage (Before and after HV tests)
9	Tests of PRDs for successful operation
10	Oil BDV test before & after HV tests
11	Sweep Frequency response analysis (SFRA) - SFRA shall be carried out at manufacturer's works with his own SFRA test set. The test shall be repeated at site with same test set.
12	Measurement of DEW point prior to dispatch of the unit filled with N_2 gas prior to dispatch - This test shall be carried out by manufacturer and results shall be submitted to CSPTCL for reference.
13	Cooler Control and RTCC Functional checks
14	Functional checks on Air cell
15	Ratio and polarity tests on Bushing Turret CTs
16	Functional checks on Buchholz Relay
17	High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

Note: All testing equipments viz. CT,PT, ampere-meter, volt-meter, watt meter, frequency meter, power analyzer, Insulation resistance test kit, winding resistance test kit, winding turns ratio test kit, tan delta & capacitance measurement test kit,

potential divider, temperature sensors, etc. shall be of appropriate class of accuracy and shall have valid calibration certificates from NABL accredited labs.

5.2.2 Type Tests: Type/ special tests to be carried out on one transformer out of lot:

5.2.2.1 **Temperature Rise Test:**
This test as per clause 16.8 of IS:2026 (Part-I) and IS:2026 (Part-II) shall be conducted at the lowest voltage tap having maximum current with 10% over load condition (both ONAN and ONAF ratings). The supplier before carrying out such tests, shall submit detailed calculations showing the alternatives possible, on various taps and for different ratings (ONAN/ONAF), of the transformer and shall recommend the combination that results in highest temperature rise, for the test. Since 315 MVA transformer is an auto transformer, the temperature rise test shall be conducted for the condition of simultaneous loading of all three windings for their respective ONAF rating i.e. 400 KV and 220 KV winding corresponding to current of 315 MVA, and 33 KV winding for 105 MVA. Loading on two windings for 315 MVA transformer for the measured losses will not be accepted. Gas chromatographic analysis of oil shall be conducted before and after heat run test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC-567. For the evaluation of the gas analysis in temperature rise test, a method will be proposed which is based on the rate of increase of particular gases and the permissible limits of minimum detectable value of gases and the maximum limit will be mutually discussed and agreed upon between the Purchaser and Supplier. This shall be treated as reference during maintenance of transformer in future.

The calibration of OTI and WTI shall be done by Transformer Manufacturer and these calibrated OTI, WTI shall be used during testing of transformer. The Sr.No.of WTI,OTI shall be recorded during testing of transformer and these indicators only shall be supplied with the transformer. During test the manufacturer selects suitable tap from CT based on gradient between the reading of WTI & OTI. This tap position is to be clearly recorded on test report so that selection of correct tap could be done at site to avoid discrepancy in temperature gradient recorded during factory test and the value recorded at site.

5.2.2.2 Tank Tank vacuum test as per details given this clause subsequently.
5.2.2.3 Tank pressure test as per details given in this clause subsequently**.**
5.2.2.4 Measurement of capacitance and tan delta to determine capacitance between winding and earth.
5.2.2.5 Following special tests other than above mentioned tests shall also be carried out as per "IS: 2026 part-I and part-III (with latest amendment) as applicable on one unit out of the ordered lot.

(i) Measurement of zero Seq. Reactance.
(ii) Measurement of acoustic noise level.
(iii) Measurement of power taken by fans and oil pumps.
(iv) Measurement of harmonic level in no load current.
(v) Lighting impulse with chop on tail on all 3 phase of HV,IV and LV terminals.
(vi) One cooler cabinet and OLTC cabinet of the transformers (preferably for thefirst unit of the lot) shall be tested for IP:55 protection in accordance with IS: 2147. In case facility for this test is not available with the manufacturer or their vendor; the test has to be carried out at

the laboratory of either CPRI or ERDA in presence of CSPTCL's representative and test report should be furnished.

5.2.3 **Additional type tests**

Following additional type tests other than type and routine tests shall also be carried out on one unit of each type :

Measurement of transferred surge on LV (tertiary) winding due to HV lightning impulse and IV lightning impulse.

5.2.4 Tank Tests

5.2.4.1 Routine Tests: Oil leakage test:

This test will be conducted on each transformer. All tanks and oil filled compartments shall be tested for oil tightness by completely filling with air or oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/sq m measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour or air during which time no leak shall occur.

5.2.4.2 Tests to be conducted on one tank out of lot:

(i) Vacuum Test

One transformer tank out of the whole lot shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m 2 absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below.

Horizontal length of flat plate (in mm)	Permanent Deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(ii) Pressure Test

One transformer tank of each size together with its radiator, conservator, vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m 2 whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released, should be within the limits specified in the table given at (i) above.

5.2.5 Routine tests on bushings

The following tests shall be conducted on bushings

5.2.5.1 Test for leakage on internal fillings.

5.2.5.2 Measurement of creepage distance, dielectric dissipation factor and capacitance.

5.2.5.3 Dry power frequency test on terminal and tapping.

5.2.5.4 Partial discharge test followed by dielectric dissipation factor and capacitance measurement.

5.2.6 **Type Tests on fittings:**

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings. The list of fittings and the type test requirement is:

i) Bushing (Type Test as per IS: 2099/ IEC: 137)

ii) Buchholz relay (Type Test as per IS: 3637 and IP-55 Test on terminal box)

iii) OLTC (Temperature Rise of contact, Short circuit current test, Mechanical test and Dielectric Test as per IEC:214 and IP-55 test on driving mechanism box)

iv) Cooler Control cabinet (IP-55 test)

v) Pressure Relief device Test

The pressure Relief Device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released.

The terminal box / boxes of PRD should conform to degree of protection as per IP-55 of IS: 13947.

vi) Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.

Air Cell (Flexible air separator) - Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per IS: 3400/ BS: 903/ IS: 7016.

vii) OTI & WTI - Switch setting & operation, Switch differential, Switch rating.

viii) Oil pump - Vacuum Test at 250 torr maximum, oil pressure test at 1 kg/cm2 for 24 hrs., Temperature rise test by resistance method, IP-55 degree of protection for terminal box.

ix) Cooling fan and motor assembly - Free air delivery, Temperature rise, sound level, running at reduced voltage, IP-55 degree of protection for terminal box.

x) Tests on Assembled Transformer:

a) Check completed transformer against approved out line drawing, provision for all fittings, finish level etc.

b) Jacking test on the assembled Transformer.

5.2.7 **Test reports:**

(a) Copies of certified test reports and oscillograms shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the required type and routine tests have been carried out and test reports have been approved by the purchaser.

(b) Copies of the test reports for the tests carried out on the ancillary apparatus shall be furnished to the purchaser for approval prior to dispatch.

(c) All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

Apart from rejection due to failure of the transformer to meet the specified test requirements the transformer shall be liable for rejection on any one of the following reasons.

a) No load loss exceeds the permissible values mentioned in principal parameters.
b) Load loss exceeds the specified values mentioned in principal parameters.
c) Impedance voltage value exceeds the guaranteed value plus tolerance.

5.2.7.1 **Inspection and Testing:**

Inspection: CSPTCL shall have access at all times to the works and all other places of manufacture where the transformers are being manufactured and the tenderer shall provide all facilities for unrestricted inspection of the tenderers works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

The contractor shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages, so that arrangements could be made for inspection.

No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

The acceptance of any quantity of Transformer & its accessories shall in no way relieve the contractor of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection if such equipments are later found to be defective.

Acceptance of condition regarding stage inspection at various stages, which will be intimated to contractor, shall be an essence of the contract to be placed against this tender.

5.2.7.2 Inspection programme:

The contractor shall chalk out a detailed inspection and testing programme for manufacturing activities for the various components. Stage inspection of core & winding and final inspection of the transformer shall be carried out at manufacturer's works in presence of CSPTCL's representative and representative of a third party i.e. CPRI/ ERDA or any other agency authorized by CSPTCL. The expenses on witness of tests by third party shall be borne by CSPTCL.

The routine tests on each transformer is to be carried out free of cost by the bidder. The rates for type & special tests for one transformer should be separately offered and the same shall be payable by CSPTCL.

5.2.7.3 **Stage inspections**:

5.2.7.3.1 The manufacturer shall indicate the inspections and checks carried out at various stages of the manufacture of the transformers. A complete record of stage inspection would be kept by the manufacturer and thus record should be made available for inspection by the representative of CSPTCL. The manufacturer should indicate the manufacturing programme and CSPTCL will have a right to depute its inspecting officers during the manufacture. Some of the inspecting stages are coil winding and core building, assembly of coil on core, the condition of the coil and core after the treatment in vacuum chamber, assembly within the transformer tank together with application of tap changer.

5.27.3.2 It may be noted that stage inspection for all the units at CSPTCL's discretion shall be done at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL at the following stages.

(a) **Fabrication stage of tank**: After fabrication, tank shall be inspected for measurement of its dimensions, thickness of sheets used and leakage test by applying requisite pressure/ vacuum.

(b) **Building up of core**: After the core is built but before its clamping, our representative will inspect the core to take complete weight of the core and also to measure approximate core loss. If necessary, a small strip of core shall also be taken for testing at CPRI/ ERDA or at any other testing laboratory of repute.

(c) **Preparation of winding:** Once the coils are prepared but before the same are fitted on to the core, stage inspection shall be done to take various measurements and also for weighment of total weight of coil of each voltage class. Measurement of resistance shall be taken and for this purpose, a small piece of conductor for each type of winding shall be made available by the manufacture. The magnetic balance test shall also be carried out during this stage inspection.

(d) **Core Coil Assembly.**

Apart from the above, CSPTCL also reserves the right to carry out stage inspections at other stages also, for which advance intimation shall be given and all necessary cooperation shall be rendered by the manufacturer.

5.2.7.4**Final inspection and testing:**

(a). In one of the transformers out of the ordered lot, all the routine, additional routine, type and special tests as mentioned in clause 6 shall be carried out as per IS:2026 (Part-I & III) at manufacturer's works in presence of CSPTCL's representative and/or representative of third party authorized by CSPTCL. In other transformers, routine & additional routine tests shall be carried out as per specifications and as per IS:2026 (Part-I & III) at manufacturer's works in presence of CSPTCL's representative and/or representative of third party authorized by CSPTCL. At the time of final inspection, the contractor shall identify each and every item/accessories of the particular transformer under testing. Unless all the items are identified, the manufacture will not be treated as complete. Serial number of bushings, serial number of tap changer and other details shall be entered into the test report to ensure that these items are not being applied to the subsequent transformer units while testing. Various tests stipulated in IS & IEC (Along with their Latest amendments) shall be performed in the presence of CSPTCL engineers or when the inspection waiver has been given, in such a case, the testing shall be done at the manufacturer's works as per IS stipulations and same should be confirmed by documentary evidence by way of Test Certificate which shall be got approved by CSPTCL.

(b). The WTI & OTI shall be calibrated during testing of transformer and serial Nos. of these instruments shall be recorded in test reports. The WTI & OTI used during testing shall be dispatched with the transformer so that installation of same OTI & WTI on transformer is done which are utilized during testing of transformer at manufacturer's works. The Bushings and Radiators on Transformer (if heat run test is conducted) during testing of transformer at manufacturers works are required to be supplied with the same transformer to avoid any mismatch / misalignment etc. during assembly of transformer. This should be noted for strict compliance and confirmed specifically.

(c). Whenever inspection call for a particular transformer is given, the letter of inspection call will accompany the following:

i) List of various fittings and accessories which are ready at the works and will be offered for inspection. The Inspecting Officer will carry the list and check the items declared to have been offered for inspection.

ii) It is expected that before a transformer is finally offered for inspection, internal testing of the transformer for various important parameters like

winding resistance, transformer losses, IR values etc. are already done. Routine test report for such tests shall also accompany the letter of inspection call so that the Inspecting Officer at the time of inspection may verify the parameters brought out in the preliminary report. Details of all tests should be clearly brought out.

iii) List of testing equipments and instruments which will be used during the inspection of the transformer with their makes, sl. No. and date of calibration, agency who conducted calibration and validity of calibration certificate should also be furnished along with the inspection call.

In case for any reasons inspection is not completed or equipment is not found to be complete with all accessories as per confirmation given with the letter of inspection call,CSPTCL will reserve the right to recover the complete cost of deputation of inspecting team to the works of the manufacturer.

5.2.7.4.1**Testing at an independent test laboratory:**

CSPTCL at its discretion may get any one of the transformer or all the transformers out of the ordered lot tested at a Govt. approved laboratory like CPRI/ ERDA for all the routine and type tests at the expenses of CSPTCL. In case, the test results are found to be deviating from the results during the inspection at manufacturer's works or the test results are found to be beyond the permissible limits as per the tender specifications and concerned standards, the whole lot of the transformer shall be liable for rejection.

5.2.7.5**Quality Assurance Plan:**

The contractor shall invariably furnish following information along with his offer, failing which the offer shall be liable for rejection.

i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw material are tested, list of tests normally curried out on row material in the presence of contractor's representative, copies of test certificates.

ii) Information and copies of test certificates as in (I) above in respect of bought out items.

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas where manual processing exists.

v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

vi) Special features provided in the equipment to make it maintenance free.

vii) List of testing equipment available with the manufacturer for final testing of equipment specified and test. Plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in "schedule of Deviations".

5.2.7.6 The contractor shall submit the following information to the purchaser.

i) Name of the raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for purchaser's inspection. The QAP and hold points shall be discussed between the purchaser and the bidder before the QAOP is finalised.

5.2.7.7 CALCULATIONS REQUIRED :

Calculations/ design data required to be submitted for power transformer:

All the important data of the transformer i.e. net weight of bare copper in each winding, weight of core without clamping fixtures, weight of core and windings, Cross section of the core, Flux density calculations, Calculations for short circuit current and its duration, Current density during short circuit, Calculations showing withstand capability of windings for thermal & mechanical stresses during short circuit conditions, Mechanical design of transformer tank etc should be invariably submitted by the Bidder. After placement of detailed contract the final design calculations shall be submitted for our verification and records.

5.2.7.7.1 Short circuit withstands capability:

In order to ensure capability of transformer to withstand short circuit forces due to most severe fault in our inter connected net work the transformer should be designed on the basis that winding are connected to an infinite bus and fault current is limited by transformer impedance alone, ignoring system impedance. The calculations to prove dynamic and thermal short circuit withstand capability of transformer shall be submitted considering the above for transformer. The design of winding assembly which is to be furnished in the drawing should be commensurate with these calculations.

5.2.7.7.2 Design of tank:

Complete mechanical design of transformer tank including details of stiffeners shall be submitted. The tank shall be designed to withstand the following without permanent distortion.

(i) Mechanical shocks during transportation.
(ii) Vacuum filling of oil at 10 milli torr in transformer with all fittings.
(iii) Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.
(iv) Short circuit forces
(v) Under seismic condition /events both horizontal/vertical .

The calculations for tank stiffeners shall be submitted to prove no. &size of stiffeners are adequate to withstand full vacuum & pressure. Drawing of tank shall be submitted indicating stiffeners.

5.2.7.7.3 Design of static end rings (SER) and Magnetic shunts:

Details of Static End Rings (SER) and magnetic shunts, if provided, shall be submitted with calculations. A drawing indicating locations, size, material of SER and magnetic shunts shall be submitted.

5.2.7.7.3 Overfluxing capability:

A curve to prove suitability of transformer to withstand various Overfluxing conditions for the duration indicated in relevant clause without core saturation shall be furnished.

5.2.7.7.4 Cooling calculations:

Calculations of tank surface for heat dissipation, details of radiators, fans for ONAN & ONAF cooling shall be provided.

5.2.7.7.5 Design Data:

On the basis of offered flux density and current density, the Bidder shall furnish following design calculations & data. :

5.2.7.7.6 Core Data:

Details of core material i.e Name of manufacturer, manufacturer's type designation for core , thickness of core, curve for Loss Vs Flux density, No of steps of Core & No of limbs, gross core area, stacking factor, Net core area, height & width of core window, center to center distance of limb, voltage per turn, wt. of core material, working flux density , core loss in watts per kg marked on graph for grade of core material & selected flux density, building factor and calculated no load loss in watts, guaranteed no load loss.

Design data for core shall be submitted. A drawing indicating details of core i.e. limbed construction, step width & thickness, core belting, top & bottom yoke plate etc shall be submitted.

5.2.7.7.7 Winding Data:

Wt. of copper for windings i.e. for HV,IV, LV, tap, cross sectional area, current density, type of coil, ID/OD/mean dia of coils, size of winding conductor including parallels, no. of turns per phase, no of spacers, length of mean turn, weight of copper without paper covering, resistance per phase of winding at 75^oC, I^2R loss at 75^oC & normal tap, eddy current & stray loss at 75^oC, total copper loss at 75^oC, guaranteed transformer losses at 75^oC. Complete details of Insulation components i.e. Top & Bottom clamping rings, washers, Pressboard blocks & cylinders, Pressboard spacers & Phase barriers, Pressboard segments etc shall be submitted indicating qty , thickness in mm, width & height, wt. Design data for winding as per clause 31.2.2 shall be submitted. Dimensioned drawings indicating details of winding, ducts, insulation, take off arrangement, clamping ring, pressure points etc shall be submitted

5.2.7.7.8 Quantity of oil:

Complete calculations of oil quantity to be utilized in transformer for first filling shall be submitted. The calculations shall indicate

(i) Volume of tank including turrets, conservator main & OLTC, volume of headers & Radiators, oil quantity in OLTC.

(ii) Oil displacement by Active parts i.e. core - coil assembly,

5.2.7.7.9 Capacity of conservator & size of air cell :

While furnishing details of conservator & air cell type sealing arrangement, the Bidder shall submit details & calculations for adequacy of size and capacity of air cell for the rating of the power transformer and also for the quantity of oil required. Catalogue of AIR CELL should be enclosed clearly marking type designation of selected size of Air cell. A drawing indicating complete details of conservator with Air cell shall be submitted.

5.2.7.7.10 Capacity of pressure relief device:

Our specification calls for supply of pressure relief device for all power transformers. Bidders must submit calculation to prove that the capacity/ rating of pressure relief device and locations of the same for the transformer will adequately meet our requirement. Constructional and design details of pressure relief device must be furnished and it should be proved by calculation that the size and setting of pressure relief device is adequate considering the rating of the transformer and quantity of oil in the transformer.

A drawing indicating complete details of PRDs & their locations on tank shall be submitted.

5.2.7.7.11 Capacity of Silica gel breather:

The Bidder shall submit details & calculations for adequacy of size and capacity of silica gel breather for the oil quantity in the power transformer.

5.2.7.7.12 Rating of on load tap changer (OLTC):

It has been our experience that due to inadequate rating of OLTC elements, the failure of OLTC components or pitting of contacts have been observed before the claimed period for maintenance. To verify the adequacy and suitability of the OLTC components, it is necessary to furnish the calculations for selecting the proper rating of transition resistance as well as the normal current rating of OLTC. The calculations shall include the temperature rise of the OLTC diverter switch and also the short circuit current considered for calculation of temperature rise.

Calculations shall be submitted to prove that the current rating of OLTC is adequate for the rating of the transformer winding taking in to account the over loading capability as per IS 6600. The basis for selection of transition resistance and its current carrying capacity shall also be submitted. In this regard the circulating current in tap winding during tap change operation through transition resistance shall be taken in to consideration. Adequacy of insulation provided in the OLTC between various parts needs to be established with specific reference to the voltage between two taps. Confirmation shall be given that the OLTC is suitable for bidirectional flow of current. The through current capacity shall be adequate to handle on continuous basis the winding current including over loading as per IS 6600. The through current rating and the rating of transition resistance shall take in to account the short time current rating of the winding. Capability to handle short circuit current to be established by calculations and also by test reports. The above Calculations for OLTC shall be submitted.

5.2.7.7.13 Capacity of Nitrogen Cylinder, pressure in Nitrogen Cylinder to be used during transportation of transformer shall be submitted.

5.2.7.7.14 The manufacturer shall carry out optimization of Dielectric design of insulation including electromagnetic design; overload & short circuit withstand capabilities. During design, transformer modeling shall be done & finite element software (FEM) may be used.
All these data shall be kept strictly CONFIDENTIAL

5.2.7.7.15 The following drawings and data are to be submitted by the contractor for approval:

(a) Outline dimensional drawings of transformer and its accessories including conservator complete with Bill of material and details of all parts, their quantity, rating & name of Vendors indicating clearances of transformer body from live terminals i.e. HV,IV,LV.
(b) Drawing of transformer tank with location of inspection windows, thickness of side/bottom/top of tank, details of stiffener.
(c) Drawing indicating limbed core construction with complete details of no., width and wt. of core laminations with size of steps; thickness of core laminations ; dimension of window; size of limbs; Gross and net core ; wt. of complete core.
(d) Drawing indicating core belting arrangement with details of belting, belting material etc.
(e) Large scale dimensioned drawings for HV,IV & LV windings of the transformer; size and no. of parallel of HV,IV, LV and of cooling

ducts, coil clamping arrangement, no./size & location of pressure screws, clamping ring; top yoke arrangement etc. The details should commensurate with the short circuit calculations submitted by you for each rating of transformer

(f) Detailed drawing of transformer tank with complete core and winding indicating clearances inside transformer tank as also passage and space for free movement of at least two persons for inspection of active parts etc .

(g) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc. for the transformers/radiators drawn to scale .

(h) Drawings giving the weights for foundations.

(i) Combined Rating and diagram plate including tap changing, which should also include details of guaranteed and measured no load and load losses as also winding resistances and percentage impedances at all taps.

(j) Schematic control and wiring diagram for all auxiliary equipment and control cubicle.

(k) Drawing showing constructional details, dimensions, mechanical & technical particulars of bushings. Arrangement of terminals and details of connection of bushing shall also be indicated in drawing with their technical particulars.

(l) Transportation drawing of transformer.

(m) Details of fittings and cable box.

(n) Drawing showing arrangement and details of tap changing gear including selector switch, diverter switch and drive mechanism.

(o) Valve Schedule plate.

(p) Oil filling instruction plate for conservator fitted with Air cell breather arrangement including equalizing arrangement if any required at the time of taking full Vacuum at site.

(q) Drawing and instruction for fitting of Air Cell.

(r) Drawing of conservator indicating internal details of air cell MOG, oil level gauge and silica gel breather pipe fitting arrangement.

(s) Drawings of all HV,IV& LV bushings with complete details meeting TS requirement.

(t) Drawings of HV,IV,LV& neutral terminal connectors indicating plate thickness, no. of nut bolts with size and other details.

(u) Drawing of foldable & detachable ladder with its complete details and fitting arrangement on transformer/ conservator tank.

(v) Drawing for HV/IV neutral earthing arrangement indicating voltage rating of insulators and its fitting arrangements, size of copper strips, terminal connectors etc.

(w) Detailed drawing indicating two views of all valves provided in the transformer tank.

(x) Detailed internal drawing of transformer indicating transportation locking arrangement provided to avoid shifting of core assembly.

(y) Drawing showing weights of transformers, cooling fan structures, FCC structures with distance from central line of transformer for casting of civil foundation for transformer and associated equipments.

(aa) Drawing of Earthing terminal box showing earthing arrangement for core, end frame, tank giving details of voltage class and current rating of terminal bushings.

(ab) Drawing indicating insulation thickness details and other arrangement provided between core assembly and bottom yoke and base of bottom of tank.

(ac) Drawing indicating details of 'O' ring gasketting arrangement provided in transformer tank covers.

(ad) Detailed Drawing of jacks.

(ae) Drawing of stiffeners provided on top, each faces/sides of tank with their number and size.

(af) Drawing indicating number, location, size of shields/ magnetic shunts and its material if provided inside the tank

(ag) Drawing indicating internal details of transformer giving complete details of clearances from live parts.

(ah) Drawing of internal IV/LV winding termination arrangement indicating minimum clearance between core and IV/LV take off lead.

(ai) Drawing for Lead termination to bottom of HV & IV Neutral Bushings

(aj) Drawing for Lead termination to bottom of HV,IV& LV bushings.

(ak) Internal drawing & design of Core & Winding indicating all attachment with identification numbers, description including take-off arrangement of lead connection for Core & End frame and related Bill of Material

(al) Locking arrangement drawing for tank top cover, core & winding with complete dimension & details.

(am) Plan view of the bottom of Bell Tank for complete details of core coil resting arrangement, indicating clearly dimensional details, material of insulation, clamping arrangement with details of nuts/ bolts, clearance from all sides provided at bottom.

(an) Drawing indicating complete details, dimension & mounting arrangement of OLTC inside the tank with respect to End frame.

(ao) Drawing indicating complete details, dimensions & fixing arrangement of static end rings if used.

(ap) Other relevant drawings.

The manufacturer shall supply four (4) copies of the drawings as listed out above, which will describe the equipment in details for approval. Three sets of instruction books, operation and maintenance manuals and spare part bulletin, shall be supplied. In addition to above two sets of manuals and drawings with test certificates for each unit to be despatched as per despatch instructions.

It will be obligatory on the part of the manufacturer to ensure that the weight of core lamination, weight of copper, weight of steel, weight of transformer tank along with fitting and accessories, quantity of oil for first filling including wastage and 10 % extra of that quantity, total weight of core plus winding after assembly, total weight of transformer and other dimension of transformer are worked out carefully. It may be noted that at the time of submission of final drawings, variation in these weights beyond the limits of (±) 5% shall not be permitted

5.2.8 **Pre-Shipment Checks at Manufacturer's Works**

5.2.8.1 Check for inter changeability of components of similar transformers for dimensions.

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

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

5.2.8.4 Gas tightness test to confirm tightness.

5.2.8.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

5.2.8.6 Storage, handling & shipping:

When the transformer is declared ready, the manufacturer has to identify each and every item associated with this unit and a complete packing list shall be prepared in advance. The equipments shall be stored and handling properly in shipping depot, while the same is under process of dispatch. The manufacturer should ensure dispatch of all the related items and accessories with a particular unit of transformer along with tank.

Tap changer, bushing, radiators and other accessories of the transformer should not be withheld for use subsequently on; units for testing purposes. If there are any items procured from sub-vendor which are to be directly installed like instrumentation, panels, control gear etc. test and inspection report for the same will be kept separately and made available to our inspecting officers.

It may be noted that "No change in any accessory or associated equipments after passing all the test successfully shall be allowed and if this is subsequently defected it shall be binding on the bidder to replace with the same item with which the initial test were conducted at his part failing which the entire test shall become null and void. The CSPTCL at its discretion may consider for rejection of the units thus supplied. The entire cost, for replacement of such rejected units thus supplied and for repeating acceptance test, shall be borne by the bidder.

5.2.8.7 Transportation:

The bidder shall include charges for fitting one Electronic impact recorder (on returnable basis) during transportation of transformers to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the manufacturer during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is installed in its foundation. The data of electronic impact recorder(s) shall be down-loaded at site and a soft copy of it shall be handed over to engineer-in-charge. Further, within three weeks the manufacturer shall communicate the interpretation of the data. In the unlikely event of impact recorder output not available at site, the equipment shall be thoroughly internally inspected by the manufacturer's representative before erection at site to ensure healthiness of the equipment.

(A). In order to conduct low voltage field testing on power transformers before unloading/ commissioning at site to determine the internal condition, the transformer shall be transported with:

(a) Small bushing (12 KV) may be installed on the bushing cover plate to represent the actual bushing.

(b) Winding leads may be routed, secured and electrically isolated from the tank walls and active part.

(c) Temporarily tests leads may be used to connect the winding leads by the small bushings (which will be removed before erection of the main bushings).

(B). Further, the manufacturer shall mount vehicle tracking system (GPRS/ GPS/ GSM based) to track the exact position of the vehicle on which the power transformer is being loaded for transportation and during detailed engineering take approval for the equipment installed.
The details of arrangement for transport configuration of power transformer (which shall be adopted by manufacturer) shall be submitted by the manufacturer to CSPTCL for approval. The price quoted by the bidder should take into account this requirement.

5.3 **Inspection and Testing at Site**

The Contractor shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage upto commissioning stage. substation bay equipment, which will be available in the respective sites and shall be referred by the contractor. However, it is contractor's responsibility to draw up and carry out such a programme duly approved by the Employer. Testing of oil sample at site shall be carried out.

5.3.1 **Receipt and Storage Checks**

5.3.1.1 Check and record condition of each package, visible parts of the transformer etc. for any damage.

5.3.1.2 Check and record the gas pressure in all the seven transformer tanks as well as in the gas cylinders.

5.3.1.3 Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

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

5.3.2 **Installation Checks**

5.3.2.1 Inspection and performance testing of accessories like tap changers,cooling fans, oil pumps etc.

5.3.2.2 (i) Check the direction of rotation of fans and pumps.
(ii) Check the bearing lubrication.

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

5.3.2.6 Leakage test on bushing before erection.

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

5.3.3.1 Pre commissioning tests at site:

(i) Insulation resistance test and polarization index.
(ii) Ratio and polarity test
(iii) DGA of oil and di-electric, tan delta and moisture content test of oil.
(iv) OLTC operational test at each tap for lower and raise operation of tap changer.
(v) Magnetic balance tests and measurement of magnetizing current.
(vi) Vector group test
(vii) Short circuit current measurement at low voltage and at all taps

(viii) Measurement of winding resistance at all taps
(ix) Tangent delta and capacitance of Transformer
(x) Tangent delta, capacitance and insulation resistance tests of bushings
(xi) Leakage current between core & tank, core & end frame, end frame and tank and between short circuited links and neutral in grounded and ungrounded conditions.
(xii) Dew point measurement and recording of pressure of nitrogen gas.
(xiii) SFRA test.
(xiv) PPM & BDV of Transformer Main Tank & OLTC oil

The SFRA test and Dew point measurement shall be carried out in presence of manufacturer's representative. The test kits shall be same as used for carrying out these tests in the factory and shall be brought by manufacturer's representative.

5.3.3.2 **Pre-Commissioning checks at site:**

a) Check the colour of silica gel breather.
b) Check the oil level in the breather housing, conservator tank, cooling system, condenser housing etc.
c) Check the bushings for conformity of connection to the line etc.
d) Check for correct operation of all protection and alarms.
   i) Buchholz relay
   ii) PRV
   ii) Excessive winding temperature
   iii) Excessive oil temperature
e) Low oil level indication
f) Check for adequate protection on electric circuit supplying the accessories.
g) Check for cleanliness of the Transformer and the surroundings.
h) Check for any other measure as prescribed by the manufacturer. Continuously observe the transformer after charging for its operation at no load for 24 hours.
i) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

5.3.3.3 **DGA of oil just before commissioning and after 24 hours energisation at site.**

5.3.3.4 **Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Employer for future record.**

6.0 Bushing Current Transformer

6.1 Current transformers shall comply with IS:2705/IEC-185.It shall be possible to remove the turret mounted current transformers from the reactor tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret. Current transformer secondary leads shall be brought out to a weatherproof terminal box near each bushing.These terminals shall be wired out tocooler control cabinet/ marshalling box using separate cables for each core.Bushing Current transformer parameters indicated in this specification are tentative and liable to

change within reasonable limits. The Contractor shall obtain Employer's approval before proceeding with the design of bushing current transformers.

6.2 **Technical Parameters**

6.2.1 In addition to WTI CT in middle phase of HV, IV & LV wdgs, following Current Transformer shall be provided for 3-ph 315 MVA,400/220/33 KV Auto Transformers bushings of 400 KV, 220 KV and Neutral

		HV Side	IV side	Neutral side
(a)	Ratio			
	Core -1	1000/1A	1000/1A	1000/1A
	Core – 2	1000/1A	1000/1A	1000/1A
(b)	Minimum knee point voltage and accuracy class :			
	Core – 1&2	2000 V Class PS	2000V Class PS	2000V Class PS
(c)	Maximum CT Resistance			
	Core – 1&2	2.5 ohms	2.5 ohms	2.5 ohms
(d)	Application			
	Core-1&2	REF relay	REF relay	REF relay
(e)	Maximum magnetisation current (at knee point voltage)	30 mA	30 mA	30 mA

7.0 **NOTE**:

Accuracy class PS as per IS: 2705. Class (for the relevant protection and duties) as per IEC 185.Parameters of WTI CT for each winding shall be provided by thecontractor.

LIST OF VENDERS FOR MAJOR ITEMS OF TRANSFORMER

S. No.	Name of Item	Supplier
1.	CRGO	M/s. Nippon steel corporation, Japan M/s. Kawasaki Corp., Japan (M/s JFE, Japan) M/s. Armco, USA, M/s. Covefi, France M/s. Salzgittar, Germany M/s. S Usinor, France M/s Transfer, France M/s Mitsubishi, Japan. M/s AST Terni, Italy M/s. EBG India Pvt Limited, (Indian Agent) for M/s GELSE NKIRCHEN, Germany M/s British Steel Corporation , UK M/s Thyseen Krupp Group of Companies M/s. POSCO, Korea M/s A.K.Steel USA
2 (a)	Winding conductor	M/s Invex Filli Isolati Speciali s.p.a. Italy M/s. Asta M/s. Smit Draad, Holland M/s. Incab Industries, Jamshedpur M/s. Sterlite Industries, Mumbai M/s. Bhandari Conductor, Mumbai/ Mandideep. M/s. Shakti Insulated Wires, Mumbai M/s KSH International Pvt Limited, Taloja M/s Delta-Trans Conductor, Mumbai M/s Vijay Electricals, Hyderabad M/s RIMA Transformers & Conductors (P) Ltd, Bangalore. M/s Lacroix and Kress (GMBH) Germany M/s Pirellicavi Italy M/s Shree Cable & Conductors M/s. Hindalco M/s. Chandra Metals M/s. BCPL Conductors
(b)	CTC Conductor	M/s Sam Dong Korea M/s Invex Filli Isolati Speciali s.p.a. Italy M/s Loc Roix AND KRESS – Germany M/s. KSH International (P) Ltd. M/s. Chandra Metals
3.	Precompressed press Board & press Board components	M/s. H. Weidmann, Switzerland M/s. Fige Holms Brruk, Swedan M/s. Senapathy Whiteley, Banglore M/s. Raman Board, Mysore
4.	Insulating Material	M/s. Dupont, USA M/s. Senapathy Whiteley, Banglore M/s. H. Weidmann, Switzerland M/s. Munksio M/s Amotfors, Sweden M/s Krammerer
5.	Air Cell	M/s PRONL, France, M/s. Swastik

S. No.	Name of Item	Supplier
		M/s. Unirub M/s. Rubber Products M/s Sukrut Udyog
6.	Gaskets	M/s. Talbros, Faridabad M/s. Cortica, Chennai M/s. Packing & Jointing, Chennai M/s Indian Rubber Products, Haridwar M/s Bombay Oil Seal Mfg. Mumbai M/s MGM Rubber Kolkata M/s Bharat Corrub Industries, Vadodara. M/s Indian work Industries M/s Works Product Pvt Ltd
7.	OIP Condensor bushing	M/s. BHEL M/s. CGL M/s. TELK M/s ASEA-MICAFIL M/s. Trench M/s. Alstom (earlier M/s. Areva) M/s. Vijai Electricals Ltd. M/s ABB
8.	Terminal Connector	M/s. Best & Crompton, Chennai M/s. PeeVee Engg., Bangalore M/s. Milind Engg., Mumbai M/s. Nootan, Baroda M/s Utsav, Baroda M/s Vinayak and Co., Mumbai M/s Megha Engg. Enterprises, Chennai M/s Klemmen Engg. Corporation , Chennai
9.	OTI/WTI with repeater	M/s. Accurate Control,UK M/s. AKM, Swedan M/s. Perfect Control, Chennai, India M/s. Preci Measure, Banglore M/s Radix Electrosystems Pvt. Ltd/ Radix Pyrotech India
10.	Magnetic oil gauge	M/s. Sukrut Udyog, Pune M/s. Yogya, Jhansi
11.	Buchholz Relay & Oil surge relays	M/s. Fukuda Instrument, Japan M/s. Atvus,Calcutta M/s. English Electric, Chennai M/s. Prayog; M/s BHEL M/s Instrument and Control, Vadodara
12.	Pressure Relief Device	M/s. Qualtrol, USA M/s. GE, USA; M/s. Sukrut Udyog, Pune
13.	Fan & Motor	M/s. Alstom (earlier Areva) M/s. CGL, Mumbai M/s. Khaitan, Calcutta. M/s EPC, Calcutta M/s Marathan
14.	Un-impregnated Densified laminated	M/s. Permali Wallace Bhopal M/s. Kit ply Assam

S. No.	Name of Item	Supplier
	wood	M/s. Mysore Polymers Banglore M/s Narmada Forest Ind. Pvt. Ltd. Bhopal. M/s Western India Plywood , Kerala M/s Rochling Detonite
15.	Valves	M/s. Leader M/s. Bombay Metal & Alloys M/s. Audco M/s. Petson M/s. Manixon M/s. Creseant M/s Precision Engg. Kottayam, M/s Eapen Joseph, Kottayam M/s Apex Piping Systems, Jalandhar M/s Liberty Engg., Mumbai M/s Niton Valves, Mumbai M/s Eapen Joseph & Co., Coimbatore M/s Oswal Agra M/s Neo Engg. Ahamedabad M/s CG Valve Udaipur
16.	MCB	M/s. Sieman M/s. MDS M/s. S&S M/s. Havell's
17.	Fuse	M/s. Siemens/ S&S / Areva / Havell's
19.	OLTC Complete	M/s. BHEL M/s. CTR M/s. TELK M/s Easun, Madras
20.	Terminal Blocks	M/s. ELMEX M/s. Technoplast, M/s. Tosha
21.	Silica gel Breather	M/s. Yogya Enterprises, Jhansi. M/s. Anusen Industries, Pune. M/s Instruments & Controls , Vadodara, India
22.	Radiator	M/s CTR Manufacturing Industries, Pune M/s Thermal Transformer Product, Bangalore M/s Exotherm, Bangalore. M/s P.E. Engg. Hyderanad. M/s Hitech Switchgear, Mumbai M/s Mahindra Electrical works M/s Triveni Electroplast
23.	Online DGA	M/s GE Kelman Transfix M/s Morgan Schaffer Calisto M/s A-E Berley Hydrocol

The list of vendors for other important equipments

Sl. No.	Description of Equipment	Manufacturer's Name
1.	Window A.C.	DIKAN/HITACHI (5 star rating)
2.	Visual Monitoring system 1) Camera	 Sony
3.	Servers/PCs	Dell/HP/Sony/Samsung
4.	1) 72.5 K.V. C.T. 2) 33 KV P.T.(72.5 KV class)	CGL / BHEL / SIEMENS / ALSTOM/ABB
5.	72.5 K.V Isolators	S&S / HIVLM / GR Power/ SIEMENS
6.	Other Equipments / Components	Reputed Make as approved by CSPTCL.

VENDOR LIST FOR FIRE PROTECTION PACKAGE

S.No.	Equipment/Material	Make
1.	Pumps (Horizontal Centrifugal)	KBL/M&P/B&C
2.	Motors (L.T.)	KIRLOSKAR/GEC SIEMENS/ ABB/CROMPTON
3.	Diesel Engine	Ruston & Hornsby (Greaves)/ KIRLOSKAR OIL ENGINE LTD
4.	Air Compressor	KGK/ELGI/INGERSOL RAND
5.	Batteries	EXIDE/AMCO/AMARA RAJA
6.	M.S./G.I Pipes	JINDAL/PRAKASH/ SAIL/ LLOYD METALS & ENGINEERS LTD.
7.	C. I. Valves	H. Sarkar/Venus/Kalpana (Gate & Check)
8.	Gun Metal Valves (Globe)	Leader
9.	Float operated Gate Valve	levcon/sigma
10.	Deluge Valve	ACE Turnkey/HD Fire
11.	Strainer (Y-Type Basket	Grandprix/Jaypee/Multitex/& arat Otofilt
12.	Hume pipe	Indian Hume Pipe/Pargate Concrete Udyog Delhi
13.	H. V. Spray Nozzles	H.D. Fire/ACE Turnkey
14.	Q. B. Detectors	H.D Fire/ACE Turnkey
15.	Pressure Gauge	H. Guru/General Instrument
16.	Pressure Switches	Indfos/Switzer/Verma Trafag
17.	Level Switches	Levcon/Sigma
18.	Level Indicator	Levcon/Sigma
19.	Level Gauge	Levcon/Sigma
20.	Hydrant Valves & Accessories	Sukan/Shah Bhogilal
21.	Hoses (Flax Canvas)	Jayshree Calcutta/Newage
22.	Solenoid Valves	AVCON/ROTEX

23.	Heat & Smoke Detectors	Apollo, U.K. /Pyrotonics / system Sensor/ Nittan
24.	Cables	Polycab/PRWE/GEMSCAB/ KEI/PARAMOUNT
25.	Fire Extinguishers	Nitin/Vijay Fire/Lightex/ Zenith/ Minimax
26.	Fire alarm Panels	ECD
27.	Annunciators	Peacon/Piri/Procon
28.	Dished Ends	Anoop Engg./Motilal/Kanara
29.	Local control panels & Annunciation panels.	Suchitra/ Vikas Engg./UNILEC/JASPER/ MIKA/ Bose corporation.
30.	Response Indicators/Hooters Break Glass Units	M.C. Engineering Delhi/ Maths, Bombay/ Mehta & Associates, Ahmedabad.

8.0 OilStorage Tank

8.1 General

This specification covers supply of oil storage tank of 15 cubic meter capacity along with complete accessories.

8.2 Standard

The oil storage tank shall be designed and fabricated as per relevant Indian Standards e.g. IS:803 or other internationally acceptable standards.

8.3 Specifications

Transformer oil storage tanks shall be transportable& rested on pneumatic tyres of adequate quantity & size. The tank shall be to cylindrical shape &mounted horizontally and made of mild steel plate of adequate thickness. Size of the storage tank shall be as follows:

Diameter 2.5 meter
Capacity 15 cubic metre

The tank shall be designed for storage of oil at a temperature of 100°C.

8.3.1 The Bidder may further note that maximum height of any part of the complete assembly of the storage tank shall not exceed 4.0 metres above road top.

8.3.2 The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatic tyres.

8.3.3 The tank shall also fitted with manhole, outside & inside access ladder, silicagel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. Bidder shall indicate the engine capacity in horse power to pull one tank completely fitted with oil. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the tank. Suitable arrangement shall also be provided to prevent overflow in the tank**. Four nos. suitable flexible steel hoses with couplers and unions each not less than 10 metre long shall also be provided**.

8.3.4 The internal & external surfaces to be painted shall be shot or sand blasted to remove all rust and scale of foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall have painted with two coats of heat & oil resistant anti-corrosive paint.

All steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of oil & weather resistant paint of a colour distinct from primary and final two coats of glossy oil & weather resistant light grey paint in accordance with shade no. 631 of IS:5. All paints shall be carefully selected to withstand heat & extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. The minimum thickness of outside painting of tank shall be 20 microns per coat the total thickness shall be within 70 to 100 microns.

8.3.5 The tank shall contain a self mounted centrifugal oil pump with inlet and outlet valves, with couplers -suitable for flexible rubber hoses and necessary switchgear for its control. There shall be no rigid connection to the pump. The pump shall be electric motor driven, and shall have a discharge of not less than 6.0 kl/hr. with a discharge head of 8.0m. The pump motor and the control cabinet shall be enclosed in a cubical with IP-55 enclosure.

9.0 **OIL SAMPLING BOTTLE**

9.1 Oil sampling bottles shall be suitable for collecting oil samples from transformers and shunt reactors, for Dissolved Gas Analysis. Bottles shall be

robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

9.2 Oil Sampling bottles shall be made of stainless steel having a capacity of1 litre.

9.3 Oil Sampling bottles shall be capable of being sealed gas-tight and shall befitted with cocks on both ends.

9.4 The design of bottle & seal shall be such that loss of hydrogen shall notexceed 5% per week.

9.5 An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle alongwith suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

9. **Oil Filter Plant Complete (6000 LPH) with required accessories with inlet / outlet**
Pipes

10.1 **SCOPE**

i) The specification provides for design manufacture testing before dispatch and delivery of the Transformer oil filtration plant. The scope covers supply of 1 No. 6000 LPH filtration plant.

ii) Technical specifications

iii) The filtration plants shall be designed such that the oil is first phased through magnetic separator/coarse filter and strainer, followed by heating chamber, filter system and finally to the degassing chamber where it is subjected to vacuum treatment which dehydrates and degasifies the oil completely. The treated oil thus obtained shall be free from all solid impurities, colloidal matter, dissolved gases, water and volatile acids.

10.2 The plant shall be fully mobile mounted on undercarriage with pneumatic tyres. Arrangement for connection to truck or jeep prime mover shall be made depending on plant weight i.e. toeing facility. Automatic brakes shall be provided.

Description of Plant:

a) The plants should be able to remove 99.9 % of particles of 1 to 4 microns.

b) Initial water content should be taken as 80 ppm and initial gas content in the oil should be taken as 10 % with these initial values, the plant should be capable of reducing the water content to 5 ppm or less and gas content should be reduced to 0.1 %.

c) It should be noted that the above reduction in water content and gas content should be achieved in 3 to 5 passes but in any case not exceeding 5 passes.

d) While the Developer may offer his own design, it may be noted that the plant should be capable of producing vacuum not less the 10 torr, in the first pass and in the final passes the plant should produce a vacuum of less the 1 torr or better. This is the oil to excessive limit.

e) For the above purpose the oil should not be heated beyond 70°C. Thus keeping Maximum temperature limit of 70°C the plant should be capable of reducing water content to less the 5 ppm and gas content to 0.2 % in maximum of 5 passes.

f) Based on the temperature of 70°C contractor should offer heating arrangement. The heaters should be 2 or 3 banks with selectors switch

and total capacity of heater should be justified based on the temperature 70°C.

g) The resistivity of oil treated by the filter machine should be above 500 x 10^{12} ohm /cm to 27° and 13 x 10^{12} ohm /cm at 90° C. Also the oil should withstand atleast 80 KV for one minute with 13 m.m. spheres 2.5 m.m. apart.

h) The tangent delta of treated oil should be below 0.005 at 90° C. and neutralisation value (total acidity max.) should be 0.03 mg/KOH/gm.

10.3 **FILTERING SYSTEM**:-

i) The developer shall provide filtering system of adequate capacity to ensure that plant offered is capable of producing end results as described under point no. 2 'Description of plant'. In this connection, the following may please be noted.

ii) Filtering system may consist of edge type filter in the form of closely compressed discs of specially treated paper. The oil from filter discs shall enter de-gasification chamber. Edge type filters shall be easily removable for maintenance purpose. For the purpose of cleaning edge type filters separate compressor with provision of air bottle of adequate capacity shall be made. The complete scheme which will form a part of main equipment shall be explained in details.

iii) Arrangements to indicate the pressure of compressed air should be done. Complete scheme for cleaning of filter system alongwith associated accessories shall be explained.

iv) Performance of filter plant design or heating system of the plants to develop designed vacuum shall be guaranteed for all variations in climatic conditions and altitude.

10.4 <u>ACCESSORIES REQUIRED TO BE OFFERED WITH FILTER PLANTS</u>:

i) Gear type input pump with pressure relief valve and flow control valve.

ii) Centrifugal type outlet pump, Vacuum pump of specified rating.

iii) Air compressor complete with storage tank pressure gauge and safety valve.

iv) Separate motors for input pump, output pump, vacuum pump and the air compressor.

v) Heating chamber with heating element.

vi) Two thermostats one on the heater chamber and another in the oil line.

vii) De-gassing chamber with Rasching ring.

viii) Magnetic strainer and preliminary filter on the input side.

ix) 2 Nos solenoid valves on the input and output side.

x) Inlet & outlet oil line valves and one additional valve for re-circulation and connecting the inlet and outlet system as shown in the drawing.

xi) Oil flow indicator on the outlet side.

xii) Pressure gauge on the inlet line and pressure gauge on the pressure tank of air compressor system.

xiii) Vacuum gauge of the required quality.

xiv) Vapour condenser system with condensate tank with required valves.

xv) Two flow switches, one for the low level of the oil and another for high level of oil.

xvi) Drain valves in the heating chamber and outlet line.
xvii) Thermometer range 0 - 150°C.
xviii) Non-return valve for the pump.
xix) Two nos hose pipes each of 15 metres length.
xx) Suitable control panel with mimic diagram.
xxi) Contractors, accessories and arrangements necessary for proper functioning of electrical system.
xxii) It shall have a meter at the outlet to measure the quantum of oil flow

SECTION- SWITCHGEAR
CHAPTER - CIRCUIT BREAKERS

1.0 GENERAL

1.1 **Standards:**

a) The offered circuit breakers shall conform to the requirement of the latest revisions of relevant standards of International Electro-Technical commission or equivalent national standards of the country with amendments of relevant standards, rules and codes, available at the time of testing at the manufacturer's work. Some of the standards & codes are listed herein for ready reference.

b) Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned below shall also be acceptable. If the equipment offered by the contractor conforms to any other standards, salient points of comparison between the standards adopted and the specific standards shall be clearly brought out in relevant schedule of technical deviation.
Copies of such standards with authentic English Translations shall be furnished along with the offer.

S N	Standard	Title
1.	IEC-56/ IS-13118	Specification for alternating current circuit breakers.
2.	IEC-376	Specification and acceptance of new supply of sulphur hexafluoride
3.	IS-375	Marking and arrangement for switchgear, busbar, main connections & auxiliary wirings.
4.	IS-2147	Degree of protection provided for enclosures for low voltage switchgear and control gear.
5.	IS-325	Specification for three phase induction motors.
6.	IS-2629	Recommended practice for hot dip galvanizing of iron and steel.
7.	IS-5	Color for ready mix paints.
8.	IS-2099	High voltage porcelain bushings.
9.	IS:5561	Electric Power connectors.

Auxiliary power supply:
Auxiliary electrical equipment shall be suitable for operation on the following supply system:-

a)	Power device (like dry motor)	400 V 3 - ϕ, 4 wire 50 Hz, neutral grounded A.C. supply
b)	D.C. alarm, control and protective device	Two nos 220 V DC sources

Each of the foregoing supplies shall be made available by the Owner at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Bidder's scope include supply of interconnecting cables, terminal boxes etc. The supply voltage may vary as shown below and all devices shall be suitable for continuous operation over entire range of voltage variations:-

S.No.	Type of Supply	Range Variation
1	AC supply voltage	+10% to (-) 25%
2	AC supply frequency	frequency (±) 5%
3	D.C. Supply	(-)15% to +15%.

1.2 420/245kV circuit breakers offered would be of sulphur hexafluoride (SF6) type only and of class C2-M2 as per IEC.

1.3 The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, Interpole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanized support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform. All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.

1.4 The support structure of circuit breaker as well as that of control cabinet shall be hot dip galvanized. All other parts shall be painted as per shade 697 of IS - 5.

2.0 DUTY REQUIREMENTS:

2.1 The circuit breakers shall be capable of performing their duties without opening resistors. The CB shall be re-strike free as per IEC under all duty conditions.

2.2 The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on a 420/245 kV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.2.1 **PRE INSERTION RESISTER**

420 kV circuit breakers wherever specified shall be provided with single step pre insertion closing resistors to limit the switching surges to a value of less than 2.3 p.u.. the resistor shall have thermal rating for the following duties:

i) TERMINAL FAULT
Close .... 1 Min .....Open .....Close open 2 min ..... close ..... 1 Min open close open.

ii) RECLOSING AGAINST TRAPPED CHARGES
Duty same as under (i) above. The first, third and fourth closures are to be on de energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. of opposite polarity.

iii) OUT OF PHASE CLOSING
One closing operation under phase opposition that is with twice the voltage across the terminals.

iv) No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished. The calculations shall take care of adverse tolerances on resistance values and time settings.

2.4 The circuit breaker shall also be capable of:

i) Interrupting line/cable charging current as per IEC without use of opening resistors.

ii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iii) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

iv) 400kV breakers shall be able to switch in and out the 400kV shunt reactor for any value from 50MVAR upto 80MVAR without giving rise to overvoltage more than 2.3 p.u. Laboratory test and or field test reports in support of the same shall be furnished alongwith the bid.

2.5 The Breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.

3.0 TOTAL BREAK TIME:

3.1 The total break time as specified under this Chapter shall not be exceeded under any of the following duties:

i) Test duties 1,2,3,4,5 (TRV as per IEC: 62271-100)

ii) Short line fault L75, L90 (- do -)

3.2 The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%)and arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the manufacturer may specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

3.3 The values guaranteed shall be supported with the type test reports.

4.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of circuit breakers shall be in accordance with requirements stated hereunder:

4.1 **Contacts**

4.1.1 The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously).

4.2 If multibreak interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand of the grading elements shall be adequate for the service conditions and duty specified.

4.3 **The SF6 Circuit Breaker shall meet the following additional requirements:**

a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.

b) All gasketted surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 1% per year. In case the leakage under the specified conditions is found to be greater than 1% after one year of commissioning of circuit breaker, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based

on actual leakage observed during first year of operation after commissioning.

c) In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as fully compatible with SF6 gas decomposition products.

d) Each pole shall form an enclosure filled with SF6 gas independent of two other poles and the SF6 density of each pole shall be monitored.

e) The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale and shall meet the following requirements:

i) It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.

f) Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

g) Sufficient SF6 gas including that will be required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition spare gas shall be supplied in separate unused cylinders as per requirement .

4.4 Provisions shall be made for attaching an operational analyser after installation of circuit breakers at site to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resisters if used, synchronisation of contacts in one pole.

5.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS):

a) The SF6 gas shall comply with IEC 376, 376A and 376B and shall be suitable in all respects for use in the switchgear under the operating conditions.

b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.

c) Test: SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 376, 376A and 376B and test certificates shall be furnished to Employer indicating all the tests as per IEC 376 for each lot of SF6 gas in stipulated copies. Gas bottles should be tested for leakage during receipt at site.

6.0 INSULATORS:

a) The porcelain of the insulators shall conform to the requirements stipulated under specifications.

b) The mechanical characteristics of insultors shall match with the requirements specified under this Chapter.

c) All insulators shall conform to IEC-6 1264 (for pressurised hollow column insulators) and IEC-233 (for others). All routine and sample tests shall be conducted on the hollow column insulators as per these standards with requirements and procedures modified as under:

i) Pressure test as a routine test.

ii) Bending load test as a routine test.

iii) Bending load test as a sample test on each lot.
iv) Burst pressure test as a sample test on each lot.
v) In addition to above, ultrasonic test shall be carried out as
additional routine test.

d) Hollow Porcelain for pressurised columns/chambers should be in one integral piece in green and fired stage.

7.0 SPARE PARTS AND MANDATORY MAINTENANCE EQUIPMENT:

The bidder shall include in his proposal spare parts and maintenance equipment.Calibration certificates of each maintenance equipment shall be supplied alongwith the equipment.

8.0 OPERATING MECHANISM AND CONTROL

8.1 **General Requirements**

8.1.1 Circuit breaker shall be operated by spring charged mechanism.Fully Pneumatically operated mechanism and hydraulically operated mechanisms shall not be acceptable. The mechanism shall be housed in a weather proof and dust proof control cabinet. Control cabinet/operating mechanism box shall be made of **aluminium sheet of adequate thickness (minimum 3 mm).** Hybrid pneumatic/spring operating mechanisms may be considered subject to approval of CSPTCL.

8.1.2 The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance for a man standing on ground.

8.1.3 The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing.

8.1.4 The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

8.1.5 A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.Electrical LED type indicator shall be provided to show open and close position of the breaker as well as Spring charge indication of the CBin the central control cabinet.

8.1.6 Working parts of the mechanism shall be corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

8.1.7 The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.

8.2 **Control:**

8.2.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons. Aux. DC supply shall be 220V DC.

8.2.2 Each breaker pole shall be provided with two (2) independent tripping circuits, pressures switches and coils each connected to a different set of

protective relays. Two independent control ckts are to be used for two separate 220 V DC sources.

8.2.3 The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However,provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the Breaker central control cabinet.

8.2.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels.

8.2.5 Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules.

8.2.6 Density Meter contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.The control logic shall be designed for fail safe operation of the Circuit Breaker.

8.2.7 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

8.2.8 The terminal connectors of the control cubilcles and the marshalling Box shall be stud type.

8.3 **Spring operated mechanism:**

a) Spring operated mechanism shall be complete with motor. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control

cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

h) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

9.0 SUPPORT STRUCTURE:

a) The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.

b) The Contractor shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility for monitoring the density/pressure of gas as well as easy accessibility to the Operating Mechanisms of individual poles.

10.0 TERMINAL CONNECTOR PAD:

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium. The terminal pad shall have protective covers which shall be removed before interconnections.It shall have six bolts and minimum clamp coverage area of 100 x100 mm.

The clamps and the connectors shall be made of materials listed below:-

a) For connection of ACSR conductors Aluminium alloy casting conforming to designation LM-6 of IS-617. Sand casting is not permitted.

b) For connecting equipment terminals made of Copper or Brass & ACSR conductor, Bi-metallic connectors made from Aluminium Alloy casting conforming to designation A6 of IS 617 with min. 2mm thick cast copper liner shall be used . Clamps for connecting GI shield shall be of malleable Iron casting. Nuts & bolts should be hot dipped galvanized.

10.1 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad

overlap in the clamp shall be 100*100 mm. It shall have minimum six bolts.

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

10.2 TESTS:

Type Tests :

It is essential to furnish following type test reports in respect of Clamps as stipulated in latest version of IS: 5561:

i. Tensile Test
ii. Resistance Test
iii. Temperature rise Test
iv. Short time current Test
v. Dimensional Check

Acceptance and Routine Tests :

For Clamps & Connectors following Acceptance & Routine tests shall be conducted:

(A) Acceptance test :

i. Visual check
ii. Tensile Test
iii. Resistance Test
iv. Dimensional Check
v. Galvanizing Test, if applicable

(B) Routine Test :

i. Visual inspection
ii. Dimensional Check.

11.0 INTERPOLE CABLING:

11.1 All cables to be used by contractor shall be armoured and shall be as per IS - 1554 (1100 Volts Grade). All cables within & between circuit breaker poles shall be supplied by the CB manufacturer. Double compression metal glands shall be used.

11.2 Only multistranded conductor shall be used. Minimum size of the conductor shallbe 2.5 sq.mm. (Copper).The individual cores shall be numbered.

11.3 The cables shall be with oxygen index Min-29 and temp. index as 250^{o}C as
per relevant standards.

12.0 FITTINGS AND ACCESSORIES

12.1 Following is a partial list of some of the major fittings and accessories to be furnished by Contractor in the Central Control cabinet. Number and exact location of these parts shall be indicated in the bid.

i) Cable glands (Double compression type), Lugs, Ferrules etc.
ii) Local/remote changeover switch.
iii) Operation counter
iv) Pressure gauges.
v) Control switches to cut off control power supply.
vi) Fuses as required.
vii) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.The terminals shall be stud and nut type.
viii) Antipumping relay.
ix) Pole discrepancy relay.
x) D.C. Supervision relays.
xi) Rating and diagram plate in accordance with IEC incorporating year of manufacture.

13.0 ADDITIONAL DATA TO BE FURNISHED

Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.

a) The temperature v/s pressure curves for each setting of density monitor alongwith details of density monitor.
b) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.
c) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
d) The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time.
e) Sectional view of non-return couplings if used for SF6 pipes.
g) Details & type of filters used in interrupter assembly and also the operating experience with such filters.
h) Details of SF6 gas:
    i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.
    ii) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.
i) A complete catalogue on operation analyser satisfying all therequirements of this Chapter.
j) The bidders shall furnish, curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage.
k) Detailed literature and schematic diagrams of switching mechanism for closing resistor showing the duration of insertion shall also be furnished alongwith the calculations in respect of thermal rating of resistors for the duties specified under clause 2.2 of this chapter in case of 420 kV circuit breaker.
l) All duty requirements as applicable to CBs specified shall be provided with the support of adequate test reports to be furnished.

m) Field test report or laboratory test report in case of CB meant for reactor
switching duty.

14.0 TESTS:

14.1 In accordance with the stipulated requirements, the circuitbreaker alongwith its operating mechanism shall conform to IEC:62271-100.

14.2 The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser's review:

i) Corona extinction voltage test.
ii) Out of phase closing test as per IEC:62271-100.
iii) Line charging breaking current for proving parameters.
iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure.
v) Seismic withstand test in unpressurised condition.
vi) Verification of the degree of protection.
vii) Low & high temperature test.(if applicable)
viii) Humidity test.(if applicable)
ix) Static Terminal Load test.
x) Critical Currents test (if applicable).
xi) Switching of Shunt Reactors.

14.3 **Routine Tests**

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

1) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic/hydraulic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyser alongwith necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised.However necessary adopter and transducers etc. if required shall have to be supplied by the bidder.
2) Measurement of Dynamic Contact resistance measurement : Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts.

14.4 **Site Tests:**

All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site.

15.1 **Control and Control Equipment:**

a) Duplicate incoming supply of 415 V, AC shall be provided by the Employer at switchyard bay marshaling box from where the Contractor shall take the feed to the operating mechanism.
b) Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.

c) A glass window shall be provided for viewing the indicating instrument/gauges. The maximum height shall be 2000 mm.

15.2 **Tests:**

In accordance with the requirements stipulated in the tender, the accessories shall conform to the type tests and shall be subjected to routine tests as per applicable standards.

16.0 TECHNICAL PARAMETERS: 420 KV & 245 KV CIRCUIT BREAKER:

S.No	Items	Requirement of 420 KV SF_6 Circuit Breaker	Requirement of 245 KV SF_6 Circuit Breaker
1.	Nominal System Voltage	400 kV rms	220 KV
2.	Highest System Voltage	420 kV rms	245 KV
3.	Rated Frequency	50 Hz	50 Hz.
4.	Rated Normal Current (A_{rms}) At 50˚C Ambient Temperature	4000 A	3150 Amperes
5.	Type	Outdoor SF_6	Outdoor SF_6
6.	Mounting Structural Details	Hot dip galvanised steel support structure .	Hot dip galvanised steel support structure .
7.	System Neutral Earthing	Effectively earthed	Effectively earthed
8.	Number Of Poles	3	3
9.	Type Of Operation a. For Feeder b. For Transformer	 -Suitable for 1 pole reclosing. ---	 -Suitable for 1 pole reclosing. -Gang operated.
10.	Phase To Phase Spacing In The Switch Yard I.E. Interpole Spacing For Breaker (Mm) SPR Duty.	6000 mm (min.)	4000 m.m.
11.	Required Ground Clearance From The Lowest Live Terminal To Structure Base Place To Be Erected On Concrete Plinth in m.m.	8000 mm	5500 m.m
12.	Height Of Concrete Plinth .	300 m.m.	300 m.m.
13.	Operating Mechanism	Spring for closing operation &spring for tripping by electrical control individually for each breaker with anti pumping & trip free.	Spring for closing operation & spring for tripping by electrical control individually for each breaker with anti pumping & trip free..
14.	Auto Reclosing Duty	Single phase &three phase Autoreclosing duty	Single phase & three phase Autoreclosing duty
15.	Rated Operating Sequence	O-0.3 sec CO -3 min-CO	O-0.3 sec CO -3 min-CO

S.No	Items	Requirement of 420 KV SF_6 Circuit Breaker	Requirement of 245 KV SF_6 Circuit Breaker
16.	"First Pole To Clear" Factor (Type Of Tripping)	1.3	1.3
17.	Max. total Closing Time (ms)	150	150
18.	Maximum Total Break Time (For Any Current Upto The Rated Breaking Current) At Limiting Conditions Of Operating Coil Voltage & Quenching Media Pressure In Milliseconds	45	50
19.	Rated Insulating Level a. 1.2/50 microsec. Lightning Impulse Withstand Voltage: (Kvp) between line terminal – ground & between terminals b. 250/ 2500 Micro Second Switching Impulse Withstand Voltage (Kvp)	1425 kVp 1050 kV peak	1050 kVp --------
20.	1 Minute Power Frequency Withstand Voltage (kV rms) a) Between line Term. – ground b) Between line terminals	520 610	460 530
21.	Maximum Radio Interference Voltage(micro volts)	1000 (at 266 kVrms at 0.5-2MHz)	1000 (at 156 kV rms at 0.5-2MHz)
22.	Minimum corona extinction voltage (kVrms)	320	-
23.	Rated line charging interrupting current at 90° Degree leading power factor (A. rms) (breaker shall be able to interrupt the line charging current as per IEC)	600A	As per IEC

S.No	Items	Requirement of 420 KV SF_6 Circuit Breaker	Requirement of 245 KV SF_6 Circuit Breaker
24.	Short circuit breaking current capacity A. Rated Short circuit breaking current capacity at rated voltage B. Symmetrical interrupting capacity (kA rms) C. Out of phase breaking current capacity	 50 kA with percentage DC component as per IEC Corresponding to minimum opening time. 50 kA rms 12.5 kA rms	 50 kA with percentage DC component as per IEC Corresponding to minimum opening time. 50 kA rms ---------
25.	Transient recovery voltage for terminal fault	As per IEC 56-2, 1971 Clause no. 7.	As per IEC 56-2, 1971 Clause no. 7.
26.	Rated characteristics for short line faults	As per IEC 56-2, 1971 Clause no. 8.	As per IEC 56-2, 1971 Clause no. 8.
27.	Rated out of phase making current	Breaking 25% of the rated fault current of twice rated voltage under out of phase conditions as per IEC publication no. 267	Breaking 25% of the rated fault current of twice rated voltage under out of phase conditions as per IEC publication no. 267
28.	Reactor loaded transformer interrupting capacity	To be specified by the tenderer	To be specified by the tenderer.
29.	Rated short circuit making current capacity	125 kAp	125 Kap
30.	Permissible limits of temperature rise	As per IEC: 62271-100	As per IEC: 62271-100
31.	Maximum difference in the instants of closing / opening of contacts (ms.) i) within a pole (milli second) ii) between poles (milli second) iii) between poles (closing)	(Timings will be at rated control voltage & rated operating & quenching media pressure.) 2.5 3.3 -- 5.0	(Timings will be at rated control voltage& rated operating & quenching media pressure.) 2.5 3.3 -- --
32.	Total min. creepage distance of support insulator in m.m.	10500	6125 m.m.
33.	Type of tripping	The tenderer should specifically mention whether the breaker is trip free or fixed trip according to IEC 56-1.	The tenderer should specifically mention whether the breaker is trip free or fixed trip according to IEC 56-1.

S.No	Items	Requirement of 420 KV SF_6 Circuit Breaker	Requirement of 245 KV SF_6 Circuit Breaker
34.	Short time current carrying capacity for three seconds (kilo amperes) KA	50 KA.	50 KA.
35.	Breaking capacity of auxiliary contacts	5 A D.C. with circuit time constant not less than 20 milli second.	5 A D.C. with circuit time constant not less than 20 milli second.
36.	Terminal rating of auxiliary contacts	10 A at 220 V DC	10 A at 220 V DC
37.	Noise level at base and upto 50 metres.	140 dB	140 dB.
38.	Seismic acceleration	0.3 g (horizontal)	0.3 g (horizontal)
39.	Rated trip coil & closing Coil Voltage.	220 V DC with specified variations	220 V DC with specified variations
40.	No. of trip/closing coils	Trip coil-2 no Closing coil-1 no	Trip coil-2 no Closing coil-1 no
41.	Max. allowable switching over voltage under any switching conditions	2.3 p.u.	2.3 p.u.
42.	PIR/PSD requirement for a. Transformer CB b. Feeder & reactor CB	 a. Not required b. Required	---------

16.1 Pre-insertion resistorrequirement

i) Rating (ohms) 400

ii) Minimum pre-insertion time 8(ms)

iii) Opening of PIR contacts

a) PIR Contacts should open immediately after closing of main circuits.

b) Atleast 5 ms prior to opening of main contacts at rated gas pressure, wherethe PIR Contacts remain closed.

16.2 **Controlled Switching Device for CB on Reactor duty** :-

Controlled switching device on receipt of a switching command should record the phase relation of the voltage with the current. The desired open switching instances should be related to a voltage for current zero crossing. For the shunt reactor, switching command shall be forwarded to the circuit breaker release by the controlled switching device with an appropriate delay and offset taking the phase relation into consideration. The commands shall be sent to the three phases of the circuit breaker independently i.e. on a phase segregated basis. In the delay time calculation the mechanical operating time and arcing time (opening operation) of the circuit breaker shall be taken into consideration. The compensated inherent delay shall be constantly calculated in relation to the defining influencing variables. Certain influencing factors change the circuit breaker mechanical operating time. The controlled switching device shall have the capability to compute

the compensated mechanical operating time using these factors. The compensated mechanical operating time shall be utilized to control the switching instant. During the switching operation, the current & voltage curves as well as other parameters shall be recorded and saved together with calculated values. An oscillogram shall also be recorded. The settings changes can be done through a PC. Also, oscillograms can be down loaded on to the PC for evaluation purposes. The controlled switching device shall be configurable for either not forwarding a switching command or forwarding the switching command uncontrolled to the circuit breaker also.

The voltage input to the controlled switching device shall be provided from only one side of the circuit breaker i.e. before circuit breaker. The current of the reactor shall be provided from the bushing CT of the reactor. The model of the CSD shall be finalised during engineering discussions.

17.0 TESTING AND COMMISSIONING

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

(a) Insulation resistance of each pole.
(b) Check adjustments, if any suggested by manufacturer.
(c) Breaker closing and opening time.
(d) Slow and Power closing operation and opening.
(e) Trip free and anti pumping operation.
(f) Minimum pick-up voltage of coils.
(g) Dynamic Contact resistance measurement.
(h) Functional checking of compressed air plant and all accessories.
(i) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
(j) Insulation resistance of control circuits, motor etc.
(k) Resistance of closing and tripping coils.
(l) SF6 gas leakage check.
(m) Dew Point Measurement
(n) Calibration of pressure switches and gas density monitor.
(q) Checking of mechanical ‘CLOSE’ interlock, wherever applicable.

CHAPTER - ISOLATORS

1.0 SCOPE:-**The bidder should clearly note that Tandem isolators shall not be accepted in any voltage class.** The isolators for 400 kV & 220 KV shall be motor operated Double Break type only. Manual operation of the isolator shall also be possible. This specification provides for design, manufacture, stage testing, inspection and testing before dispatch, packing and delivery of Isolators without /with earth switch (Dis-connectors and support / post rotating type solid-core insulators).

1.1 The Isolators and accessories shall conform in general to below given standards except to the extent explicitly modified in specification.

S.No.	Standard No.	Title
1	IS:9921	Alternating current isolators (disconnectors) and earthing switches.
2	IS:129	---- do ----
3	IS:2544	Insulators
4	IS:2147	Degree of protection provided by enclosures.
5	IS:4691	---- do ----
6	IS:325	Three phase induction motor
7	IS:4722	Rotating electrical machines
8	IS:2629	Recommended practice for hot dip galvanising of iron and steel.
9	IS:4759	Hot dip galvanisation coating on structural steel.
10	IS:2633	Method of testing, weight, thickness & uniformity of coating on fasteners.
11	IS:1573	Electroplated coating of zinc on iron & steel.
12	IS:3033	Spring Washers
13	IS:2016	Plain Washers

1.2 Isolators shall be outdoor, off-load type, mechanically individual pole operating type. Earth switches shall be provided on Isolators wherever called for.

1.3 Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following.

1.3.1 Isolator assembled with complete base frame, linkages, operating mechanism, control cabinet, interlocks etc.

1.3.2 All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

2.0 DUTY REQUIREMENTS:

a) Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

b) The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

c) In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in specifications.

d) The earthing switches shall be capable of discharging trapped charges of the associated lines.

e) The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make/break operation.

f) The isolator shall be capable of making/breaking magnetising current of 0.7A at 0.15 power factor and capacitive current of 0.7A at 0.15 power factor at rated voltage.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of Horizontal Double Break Isolators (**Tandem isolators are not acceptable),** earth switches and accessories shall be in accordance with requirements stated hereunder:

3.1 **Contacts:**

a) The contacts shall be self aligning and self cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.

b) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.

c) Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.

3.2 **Base :**

Each single pole of the isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure.

3.3 **Blades :**

a) All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on currentcarrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.

b) The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Corona shields/rings etc., shall be made up of aluminium/ aluminium alloy.

c) Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

d) The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. i.e. after every 1000 operations or after 5 years whichever is earlier.

3.4 **Insulator :**

a) The insulator shall conform to IS: 2544 and/or IEC-168. The porcelain of the insulator shall conform to the requirements and shall have a minimum cantilever strength of 800/800 Kgs. for 420/245 kV insulators respectively.

b) Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

c) The parameters of the insulators shall meet the requirements.

d) Insulator shall be type and routine tested as per IEC-168. Besides following additional tests shall also be conducted:

(i) Bending load test in four directions at 50% of minimum bending load guaranteed on all insulators, as a routine test.

(ii) Bending load test in four directions at 100% of minimum bending load as a sample test on each lot.

(iii) Torsional test on sample insulators of a lot.

(iv) Ultrasonic test as a routine test.

e) For 420 kV Insulator : (For Isolator)

Top PCD	=	127 mm
No. of holes	=	4 x M16
Bottom PCD	=	300 mm
No. of holes	=	8 x 18 dia

f) For 245 kV Insulator : (For Isolator)

Top PCD	=	127 mm
No. of holes	=	4 x M16
Bottom PCD	=	254 mm
No. of holes	=	8 x 18 dia

3.5 **Name Plate :**

The name plate shall conform to the requirements of IEC incorporating year of manufacture.

4.0 EARTHING SWITCHES :

a) Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts.

b) The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

c) Earthing switches shall be only locally operated.

d) The earthing switches shall be constructionally interlocked with the isolator so that the earthing switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks.Suitable mechanical arrangement shall be provided for de-linking electrical drive for mechanical operation.

e) Each earth switch shall be provided with flexible copper/aluminium braids for connection to earth terminal. These

braids shall have the same short time current carrying capacity as the earth blade. The ransfer of fault current through swivel connection will not be accepted.

f) The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

g) The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat

h) Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

h) The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

i) The earth switches shall also comply with the requirements of IEC1129, 1992 in respect of induced current switching duty as defined for Class-B earthing switches.

5.0 OPERATING MECHANISM :

a) The bidder shall offer motor operated Isolators and earth switches.

b) Control cabinet/operating mechanism box shall be made of aluminiumsheet of adequate thickness (minimum 3 mm).

c) A "Local/Remote" selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.

d) Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

d) Motor shall be an AC motor and conform to the requirements.

f) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

g) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.

h) Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting.

i) The test report for blocked rotor test of motor shall be submitted as per the requirement of Technical Specification.

6.0 OPERATION :

a) The Isolator and earth switches shall be mechanically individual pole operated and be so wired to have the remote /local controlas gang operated .The operating mechanism of the three poles shall be well synchronized and interlocked.

b) The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth

switches shall be provided with "over center" device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

c) Each isolator/pole of isolator and earthswitch shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. The manual operating handle shall have provision for pad locking. The operating handle shall be located at a height of 1000 mm(approximately) from the base of isolator support structure.

d) The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.
Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods! pipes shall be provided with suitable universal couplings to account for any angular misalignment.

e) All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.

f) Signalling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signalling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is atleast 80% of the isolating distance.

g) The position of movable contact system (main blades) of each of the Isolators and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earthing switch. The indicator shall be of metal and shall be visible from operating level.

h) The contractor shall furnish the following details alongwith quality norms, during detailed engineering stage.
   (i) Current transfer arrangement from main blades of isolator alongwith milli volt drop immediately across transfer point.
   (ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator alongwith stoppers to prevent over travel.

7.0 TERMINAL CLAMPS &CONNECTORS:

The clamps and the connectors shall be made of materials listed below:-

a) For connection ACSR conductors Aluminium alloy casting conforming to designation LM-6 of IS-617. Sand casting is not permitted.

b) For connecting equipment terminals made of Copper or Brass & ACSR conductor, Bi-metallic connectors made from Aluminium Alloy casting conforming to designation A6 of IS 617 with 2 mm thick cast copper liner shall be used. Clamps for connecting GI shield

shall be of malleable Iron casting. Nuts & bolts should be hot dipped galvanized.

7.1 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mmshall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

7.2 TESTS:

Type Tests :

It is essential to furnish following type test reports in respect of Clamps as stipulated in latest version of IS: 5561:

i. Tensile Test
ii. Resistance Test
iii. Temperature rise Test
iv. Short time current Test
v. Dimensional Check
vi. Galvanizing Test, if applicable

Acceptance and Routine Tests :

For Clamps & Connectors following Acceptance & Routine tests shall be conducted:

(A) Acceptance test :

i. Visual check
ii. Tensile Test
iii. Resistance Test
iv. Dimensional Check

v. Galvanizing Test, if applicable

(B) Routine Test :

i. Visual inspection

ii. Dimensional Check.

8.0 SUPPORT STRUCTURE:

420 kV and 245 kV Isolators shall be suitable for mounting on support structures to be supplied.

9.0 TESTS:

9.1 The isolators alongwith its earthing switch and operating mechanism should have been type tested as per IEC/IS and shall be subjected to routine tests in accordance with IEC-129/IEC-1 129. Power frequency voltage withstand tests shall be performed on atleast one completely assembled isolator pole of each type. Alternatively, power frequency test may be performed on two nos. of Post Insulators (complete) for each voltage rating and type of Isolator. Minimum 50 Nos. mechanical operations will be carried out on 1 (one) isolator out of every ten Isolators assembled completely with all accessories as acceptance test for the lot.

9.2 The test reports of the type tests and the following additional type tests shall also be submitted for the Purchaser's review.

(i) Radio interference voltage test .

(ii) Corona Extinction Voltage test (for 420 kV Isolators only).

(iii) Seismic withstand test on isolator mounted on Support structure. The test shall be performed in the following position :

Isolator open E/S Closed
Isolator open E/S Open
Isolator Closed E/S Open

9.3 Site Tests:

All routine tests including 50 operation test, except power frequency dry voltage withstand test on isolator shall be repeated on completely assembled isolator of each type at site.

10.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Bidder shall include in his proposal mandatory spare parts.

11.0 TECHNICAL PARAMETERS:

(In addition to those specified under other para)

11.1 420 kV & 220 kV ISOLATORS:

Sr	Particulars	Technical Parameter of 400 kV Isolators	Technical Parameter of 220 kV Isolators
1	Rated Freq.	50 HZ	50 HZ
2	Type	Outdoor, off load type	Outdoor, off load type
2	System earthing	Effectively earthed	Effectively earthed
3	No. of phases(poles)	3 ph. electrically gang operated	3 ph. gang electrically operated
4	Safe duration of overload		
	a) 150% of rated current	5 minutes	5 minutes
	b) 120% of rated current	30 minutes	30 minutes
5	Rated voltage	420 KV RMS	245 KV RMS
6	Type of disconnect	Double Break	Double Break

Sr	Particulars	Technical Parameter of 400 kV Isolators	Technical Parameter of 220 kV Isolators
7	Rated Normal current (A rms)	2000	2500
8	Rated short time withstand current for 1 secs (KA RMS) of main & E/S	50	50
9	Rated peak current of main switch & E/S (KA peak)	125	125
10	Rated short time making current of E/S (KA peak)	125	125
11	1.2/50 microsec impulse withstand voltage (kVp)		
	a) across isolating distance	1425	1200
	b) To earth & between poles	1425	1050
12	One minute Power Freq. Withstand voltage KV(rms)		
	a) across isolating distance	610	530
	b) To earth & between poles	520	460
13	Minimum creepage distance (mm)	10500	6125
14	Rated mech. Term load		
	(i) straight load(Kg.)	As per IEC -129 (1984)	As per IEC -129 (1984)
	(ii) Across load(Kg.)	As per IEC -129 (1984)	As per IEC -129 (1984)
15	Rated magnetising current/ capacitive current make & break at 0.15 power factor(A rms)	0.7	0.7
16	Minimum clearances		
	a) ph to earth(mm)	3500	2150
	b) ph to ph (mm)	4200	2350
17	Ph to ph spacing for installation	6000	4000
18	Height of lowest live point above ground level (mm)	6500	5000
19	PCD of insulators to be provided Top No. of holes Bottom No. of holes	 127 mm 4xM16 300 mm 8x18 dia	 127 mm 4xM16 225 mm 8x18 dia
20	Current density in current carrying parts	Shall not be more than 1.5 A per sq mm for copper parts and 1 A per sq mm for Al parts	Shall not be more than 1.5 A per sq for copper parts and 1 A per sq mm for Al parts
21	Seismic acceleration	0.3g horizontal	0.3g horizontal
22	Max. radio interference volts(microvolts)	1000 (at 266 kV rms)	1000 (at 156 kV rms)

Sr	Particulars	Technical Parameter of 400 kV Isolators	Technical Parameter of 220 kV Isolators
23	Rating of aux. contacts	10 A at 220 V DC; Travel of aux. contact shall be suitable for Busbar current switching	10 A at 220 V DC: Travel of aux. contact shall be suitable for Busbar current switching
24	Breaking capacity of aux. contacts	2A DC with circuit time constant of not less than 20 ms	2A DC with circuit time constant of not less than 20 ms
25	Operating time	12 ms or less	12 ms or less
26	Operating mechanism of isolator of earth switch	A.C. Motor operated as well as manual operated	A.C. Motor operated as well as manual operated
27	Corona extinction volts(kV rms)	320 (min.)	

11.2 No. of auxiliary contacts on each isolator — Besides requirement of this spec., the bidder shall wire up 5 NO + 5 NC to TBs (Reversible) for Purchaser's future use.

11.3 No. of auxiliary contacts on each earthing switch — Besides requirement of this spec., the bidder shall wire up 3 NO + 3 NC to TBs (Reversible) for Purchaser's future use.

11.4 Number of terminal in control cabinet (Interpole cabling shall be supplied by Contractor) — All contacts & control circuits are to be wired upto control cabinet plus 24 spare terminals evenly distributed.

12.0 TESTING AND COMMISSIONING

12.1 An indicative list of tests on isolator and earth switch is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor 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 of each pole.
(b) Manual and electrical operation and interlocks.
(c) Insulation resistance of control circuits and motors.
(d) Ground connections.
(e) Contact resistance measurement at 100 Amps DC.
(f) Proper alignment so as to minimise to the extreme possible the vibration during operation.
(g) Measurement of operating Torque for isolator and Earth switch.
(h) Resistance of operating and interlocks coils.
(i) Functional check of the control schematic and electrical &mechanical interlocks.

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CHAPTER - INSTRUMENT TRANSFORMERS
TECHNICAL SPECIFICATION FOR INSTRUMENT TRANSFORMERS

1.0 Scope:

This specification provides for design, manufacture, inspection and testing before dispatch, packing and delivery of outdoor instrument transformer (CT, PT & CVT) for protection and metering services 400/220 KV Sub-stations in the state.

2.0 Standards:

The rating as well as performance and testing of the instrument transformers shall conform but not limited to the latest revision and amendments available of all the relevant standards as listed hereunder.

SN	Standard No.	Title
1	IS 2165	Insulation co-ordination for equipment of 100 KV and above
2	IS 2705 (I – IV)	Current transformers
3	IS 2099	High voltage porcelain bushings
4	IS 3347	Dimensions of porcelain transformer bushings
5	IS 2071	Method of high voltage testing
6	IS 335	Insulating oil for transformers and switchgears
7	IS 2147	Degree of protection provided by enclosures for low voltage switchgear and control.
8	IEC 185	Current transformers
9	IEC 270	Partial discharge measurement
10	IEC 44 (4)	Instrument transformer measurement for P.D.s
11	IEC 171	Insulation co-ordination
12	IEC 60	High voltage testing techniques
13	IEC 8263	Method of R.I.V. test on high voltage insulators
14	IS 3156 (Part-IV)	Capacitor voltage transformers
15	IEC 186	Voltage transformers
16	IEC 186 A	First supplement of IEC publication 186
17	IEC 358	Coupling capacitor divider
18	IS 9348	Coupling capacitor and capacitor dividers
19		Indian electricity rules 1956.

1.0 GENERAL :

1.1 The instrument transformers and accessories shall conform to the latest version of the standards specified above except to the extent explicitly modified in the specification.

1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

1.3 The instrument transformer tank along with top metallic shall be hot dip galvanized.

1.4 The impregnation details along with tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

2.0 CONSTRUCTION FEATURES :

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated here under:

2.1 **Bushing/Insulators:**

a) Instrument transformers shall be of 420/245kV class, oil filled, suitable for outdoor service and upright mounting on steel structures.
b) Bushings/Insulators shall conform to IS/IEC requirements. The bushing/insulator for CT shall be one piece without any metallic flange joint.
c) Bushings shall be provided with oil filling and drain plugs, oil sight glass of CT and for electromagnetic unit of CVT, etc. The bushing/insulator of instrument transformer shall have a cantilever strength of not less than 500 kg and 350 kg for 420/245kV Instrument transformers respectively .
d) Instruments transformers shall be hermetically sealed units. Bidder/ Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers along with the bid such as nitrogen seal/bellow etc.Bidder/Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.
e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

2.2 **Terminal box/Marshalling box :**

Terminal box shall conform to the IS/IEC requirements.

2.3 **Insulating Oil :**

Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IS: 335 (required for first filling).

2.4 **Name Plate :**

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the name plate. The rated thermal current in case of CT shall also be marked on the name plate.The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 CURRENT TRANSFORMERS :

a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case "Bar primary" inverted type current transformers are offered the manufacturer will meet following additional requirements:
   i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
   ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.
   iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.
   iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.
   (v) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.

b) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT

parameters.

c) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.
d) Facilities shall be provided at terminal blocks in the marshalling box for star or delta formation, short circuiting and grounding of CT secondary terminals.
e) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
f) For 420 kV class CTs, 2000/1 ratio the rated extended primary current shall be 120% However, at 2000/1, ratio the CT shall be thermally rated for 200% for 15 minutes and 120% continuous. For 245 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs. For 420/245kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens strictly as per the accuracy class in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.
g) For 420/245kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core.
h) The current transformers should be suitable for mounting on lattice/pipesupport structure to be provided by the Contractor.

4.0 VOLTAGE TRANSFORMERS:

a) 420/245kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling.
b) Voltage transformers secondaries shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the CVTs shall be terminated to the stud type non - disconnecting terminal blocks in the individual phase secondary boxes via the fuse.
c) CVTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further earthing link with fastener to be provided for HF terminal.
d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.
e) The damping device which should be permanently connected to one of the secondary windings, should be capable of suppressing the Ferro resonance oscillations.
f) The accuracy of 0.2 on secondary should be maintained through out the entire burden range upto 200 VA for 400 & 245 kV CVTs on all the metering secondary windings without any adjustments during operation.
g) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

h) A protective surge arrester shall be provided to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

5.0 TERMINAL CONNECTORS :

5.01 TERMINAL CONNECTOR PAD:

The CT terminal pads shall be made up of high quality electrolytic copper or aluminium. The terminal pad shall have protective covers which shall be removed before interconnections.It shall have six bolts and minimum clamp coverage area of 100 x100 mm.

5.02 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm. It shall have six bolts.

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

6.0 TESTS :

6.1 Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC:44-1/IS:2705 and IEC:186/IS:3 156 respectively.

6.2 The test reports of the type tests and the following additional type tests shall also be submitted for the Purchaser's review.

a) **Current transformers :**

i) Radio interference test .
ii) Seismic withstand test.
iii) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit.
iv) Thermal co-efficient test i.e. measurement of tan delta as a function of temperature (at ambient and between 80oC & 90oC) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um/'J3)
v) The current transformer shall be subjected to Fast Transient test by any one of the following two methods given below to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. Alternatively, method as per IEC:44-1 may be followed:

Method I : 600 negative polarity lightning impulses chopped on crest will be applied to current transformer. The opposite polarity amplitude must be limited to 50% of crest value when the wave is chopped. Impulse crest values will be 1000 kVp for 420 kV CTs. One impulse per minute shall be applied and every 50 impulse high frequency currents form the windings and total current to earth will be recorded and be compared with reference currents recorded applying one or more (max 20) reduced chopped impulses of 50% of test value.

Oil samples will be taken before and 3 days after the test. Gas analysis must not show appreciable rate of increase in various gases related with the results of the analysis performed before test.

Total sum of crest values of current through secondaries must not exceed 5% of the crest value of total current to earth.

CT must withstand dielectric tests after this test to pass the test.

Method II : 100 negative polarity impulses with a rise and fall time of less than 0.25 microsecond having 950 kV for 420 kV CT corrected to atmospheric condition shall be applied at one minute interval and total current through insulation of earth will be recorded. The amplitude of first opposite polarity should be limited to 50% of the chopped impulse crest value. Voltage and total current wave shapes shall be recorded after every 10 impulses, and will be compared with reference wave shapes recorded before test at 50% of test values.

Oil sample shall be taken before and 3 days after the test and CT shall be deemed to have passed the test if the increase in gas content before and after test is not appreciable.

b) **Voltage transformers:**

i) High frequency capacitance and equivalent series resistance measurement (as per IEC-358).
ii) Seismic withstand test.
iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-358).
iv) Determination of temperature coefficient test (as per IEC-358).
v) Radio interference test.
vi) The Ferro-resonance type test shall be carried out on the complete CVT.

6.3 The current and voltage transformer shall be subjected to the following routine/site tests in addition to routine tests as per IEC/IS.

a) **CURRENT TRANSFORMERS :**

ROUTINE TESTS :

i) Measurement of Capacitance and Dissipation factor.
ii) High voltage power frequency withstand test on Secondary Winding.
iii) Over-voltage inter turn test (as per BS :3938).
iv) Oil leakage test.
v) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/'J3.
vi) Measurement of partial discharge shall be carried out as per IEC.

SITE TESTS :

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Bidder/Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

b) **VOLTAGE TRANSFORMERS:**

i) Capacitance and loss angle measurement before and after voltage test (as per IEC:358).
ii) Partial discharge test on capacitor dividers (as per IEC-358).
iii) Sealing test (as per IEC-358).

7.0 SPARE PARTS AND MAINTENANCE EQUIPMENT :

The contractor shall include in his proposal spare parts equipment in accordance with requirements of Project.

8.0 TECHNICAL PARAMETERS:

A. 420 kV & 220 kV CURRENT TRANSFORMERS :

S. No.	PARTICULARS	400KV CT	220KV CT
1.	Type	Single phase, oil filled Hermetically sealed /outdoor type	Single phase, oil filled Hermetically sealed /outdoor type
2.	Type of mounting	Pedestal Type	Pedestal Type
3.	**Suitable for system Frequency**	**50 Hz**	**50 Hz**
4.	Highest System voltage	420(kV rms)	245(kV rms)
5.	Ratio(6 no. cores) Core –I,II,III,IV,V,VI	2000-1000/1	1600-800/1 Amp.
6.	Accuracy class & related VA burden Core –I,II,IV,V Core- III, Core -VI	PS - --- 0.2s - 15VA 0.2s – 15 VA	PS - --- 0.2s - 15VA 0.2s– 15 VA
7.	Ratio taps	On secondary side.	On secondary side.
8.	Method of earthing the system	Effectively earthed	Effectively earthed
9.	Rated continuous thermal current (A)	120%	120%

S. No.	PARTICULARS	400KV CT	220KV CT
11.	Acceptable partial discharge level at 1.2/ √3 times the rated voltage.	5 pico-coulmbs Max.	5 pico-coulmbs Max.
12.	Max. radio interference voltage at 1.1 times the rated voltage	Less than 1000 micro volt	Less than 1000 micro volt
13.	Rated Insulation Level A. 1.2/50microsec full wave impulse withstand voltage between line terminal & ground B. 250/2500 microsec. switching impulse withstand voltage (kVp)	 1425 kVp 1050 kVp	 1050 kVp ----
14.	One minute power frequency withstandvoltage between line terminal & ground.	630 kV rms	460KV rms
15.	One minute Power frequency withstand volt for secondary & earth .	5 KV	5 KV
16.	Min. creepage distance of porcelain housing (mm)	10500	6125
17	Rated short time withstand current for 1 second duration (kA rms)	50	50
18	Rated dynamic withstand current (kAp)	100	100
19.	Min.corona extinction voltage (KV rms)	320	156
20.	Min knee point voltage Vk (Core I,II)	2000/1000	1600/800
21.	Min knee point voltage Vk (Core IV,V)	4000/2000	1600/800
21.	Min knee point voltage Vk (Core III)	-	-
22.	Max. magnetizing current at Guaranteed Vk (mA)	30 (for 2000/1) 60 (for 1000/1)	25 (for 1600/1) 50 (for 800/1)
23.	Seismic acceleration	0.3g	0.3g
24.	Grade of Oil	EHV Gr.I as per IS:355	EHV Gr.I as per IS:355
25.	Secondary resistance of CTs	10 ohms for 2000A 05 ohms for 1000A	06 ohms for 1600A 04 ohms for 800A

S. No.	PARTICULARS	400KV CT	220KV CT
26.	Flux density at knee point voltage for CTs	1.4 Tesla	1.4 Tesla
28.	Number of primary turns	4(Max)	4(Max)
29.	Current density in primary winding at rated primary current	Maximum 1.5 A/sq.mm	Maximum 1.5 A/sq.mm
30.	Primary to earth Insulation resistance At 30 deg. C	Minimum 20,000 M Ohm	Minimum 20,000 M Ohm
31.	Dielectric dissipation factor (Tan delta) at 1/ √3 rated voltage & ambient temperature	Max 0.005	Max 0.005
32	Oil quantity	minimum 15% of total weight of CT	minimum 15% of total weight of CT
33	Temperature rise of primary winding with permissible overloading;	Should be 5 deg less than prescribed in ISS	Should be 5 deg less than prescribed in ISS

D. 420 kV & 220 kV VOLTAGE TRANSFORMERS :

S. No.	Particulars	400 KV CVT	220 KV CVT.
1.	Type	Single phase, out door type CVT.	Single phase, out door type CVT.
2.	Manufacturer's type /designation	Hermetically sealed, oil filled	Hermetically sealed, oil filled
3.	Rated voltage kV rms	420	245
4.	Rated frequency	50 Hz	50 Hz
5.	Rated primary voltage	$400/\sqrt{3}$ KV	$220/\sqrt{3}$ KV
6.	Number of secondary windings	four	Four
7.	Rated secondary voltage		
	i. Winding -I	$110/\sqrt{3}$ Volts	$110/\sqrt{3}$ Volts
	ii. Winding -II	$110/\sqrt{3}$ Volts	$110/\sqrt{3}$ Volts
	iii. Winding –III	$110/\sqrt{3}$ Volts	$110/\sqrt{3}$ Volts
	iv. Winding –IV	$110/\sqrt{3}$ Volts	$110/\sqrt{3}$ Volts
8.	Rated burden		
	i. Winding –I& II	50 VA	50 VA
	ii. Winding -III	100 VA	100 VA
	iii. Winding -IV	100 VA	100 VA

S. No.	Particulars	400 KV CVT	220 KV CVT.
	Rated total thermal output(VA)	750 VA	500 VA
9.	Accuracy class		
	i. Winding –I& II (for metering)	0.2	0.2
	ii. Winding -III (for protection)	3P	3P
	iii. Winding -IV (for protection)	3 P	3 P
10.	Max. ratio error with rated burden and 5% normal primary voltage	As per IS 3156 - 1992	As per IS 3156 - 1992
11.	Max. phase angle error with rated burden and 5% normal primary voltage	As per IS 3156 - 1992	As per IS 3156 - 1992
12.	Grade of oil	EHV Grade, as per IS.355	EHV Grade, as per IS.355
13.	Temperature rise at 1.2 times rated voltage with rated burden at 50 ^{0}C Ambient.	45 ^{0}C (Max.)	45 ^{0}C (Max.)
14.	Rated volt.factor & time	1.25 / continuous, 1.5 / 30 seconds	1.25 / continuous, 1.5 / 30 seconds
15.	Temperature rise for 12 above	As per IS 3156	As per IS 3156
16.	One minute power frequency withstand test (dry& wet) voltage	630 KV rms	460 KV rms
17.	1.2/50 micro second lighting impulse wave withstand test voltage	1425 KV (peak)	1050 KV (peak)
18	250/2500 micro second switching impulse wave withstand test voltage	1050 KV (peak)	------
19.	One minute power frequency withstand voltage on secondaries	3 KV	3 KV
20.	One minute power frequency withstand voltage on secondary HF terminal	10 KV rms for exposed terminal & 4 kV rms for terminal enclosed in water proof box	10 KV rms for exposed terminal & 4 kV rms for terminal enclosed in water proof box
21.	Total min. creepage distance	10500 mm	6125 mm
22.	Surface treatment	Hot dip galvanised	Hot dip galvanised
23.	Corona extinction voltage (kV rms)	320 (min.)	156 (min.)

S. No.	Particulars	400 KV CVT	220 KV CVT.
24.	Max. radio interference voltage for freq.0.5-2MHz (micro volt)	1000	1000
25.	System neutral earthing	Effectively Earth	Effectively Earth
26.	Seismic acceleration	0.3g horizontal	0.3g horizontal
27.	Max. Partial discharge	10 pc	10 pc
28.	Standard reference range of frequency for which the accuracies are valid	96% to 102 % for protection and 99% to 101% for metering	96% to 102 % for protection and 99% to 101% for metering
29.	Capacitance (pf)	8800	4400

9.0 TESTING & COMMISSIONING

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

9.2 **Current Transformers**

(a) Insulation Resistance Test for primary and secondary.
(b) Polarity test
(c) Ratio identification test - checking of all ratios on all cores by primary injection of current.
(d) Dielectric test of oil (wherever applicable).
(e) Magnetising characteristics test.
(f) Tan delta and capacitance measurement
(g) Secondary winding resistance measurement

9.3 **Voltage Transformers/Capacitive Voltage Transformers**

(a) Insulation Resistance test for primary (if applicable) and secondary winding.
(b) Polarity test
(c) Ratio test
(d) Dielectric test of oil (wherever applicable).
(e) Tan delta and capacitance measurement between :-
  (i) HV - HF point
  (ii) HF Point - Ground point of Intermediate Transformer.
  (iii) HV - Ground point of Intermediate Transformer primary winding
(f) Secondary winding resistance measurement.

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SURGE ARRESTERS

1.0 GENERAL:

1.1 The surge arrestors shall conform to the latest editions and amendments available of the standards listed hereunder:-

S. N.	Standard reference No.	TITLE
1	IEC: 60099-4	Specification for metal oxide surge arrestors without gaps for surge arrestors without gaps for AC system.
2	IS: 3070 (Part)	Specification for lightning arrestors for AC system part-I
3	IS: 4959	Hot Dip Zinc coating on structural steel and Zinc coated articles
4	IS: 2633	Method for testing uniformity of zinc coated articles.
5	IS: 5621	Specification for large hollow porcelain for use in electrical installations
6	IS: 2147	Degree of protection provided by enclosures for low voltage switchgear & Controls

1.2 Arresters shall be of hermetically sealed units, self supporting construction, suitable for mounting on support structures to be supplied by the Contractor.

2.0 DUTY REQUIREMENTS:

a. The surge arresters shall be of heavy duty station class and gapless type without any series or shunt gaps.

b. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

c. 420 kV class Surge arresters shall be capable of discharging of severe re-energisation switching surges on a 400 kV, 450 km long line with Surge impedance of 300 ohms and capacitance of 11986 nF/km and over voltage factor of 2.3 p.u.

d. 420 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for a 420 kV system on two successive operation followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:

705 kVp for 3 peaks
580 kVp for 0.1 Sec
565 kVp for 1 seconds
550 kVp for 10 seconds

e. 245 kV class arrester shall be capable for discharging energy equivalent to class 3 of IEC for 245kV system on two successive operations.

f. The surge arresters shall be suitable for withstanding forces as defined in other Para.

g. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured

reference voltage.

h. The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below:-

Equipment to be protected	**Lightning impulse (kVp) for 420 kV system**	**Switching surge (kVp) for 420 kV system**	**Lightning impulse (kVp) for 245 kV system**
Power transformer	+ 1425	+ 1050	+ 950
Instrument Transformer	+ 1425	+ 1050	+ 1050
Reactor	+ 1425	+ 1050	-
CB/Isolator Phase to ground	+ 1425	+ 1050	+ 1050
Across open	+ 1425	+ 900	+ 1200
Contacts	(-/+240)	(-/+345)	

I) the duty cycle of CB installed in 420/245kV System of the Purchaser shall be O-0.3 sec-CO-3 min-CO. The Surge Arrester shall be suitable for such circuit breaker duties in the system.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

a) The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

b) The surge arresters shall be fitted with pressure relief devices suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure. Details shall be furnished in the bids alongwith quality checks.

c) The arresters shall not fail due to arrester porcelain contamination.

d) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

e) Outer insulator shall be porcelain conforming to requirements stipulated in IS/IEC. Terminal connectors shall conform to requirements.Porcelain housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

f) The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.

g) The name plate shall conform to the requirements of IEC incorporating the year of manufacture.

h) The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer formed across each block are to be furnished. Metalizing coating thickness for reduced resistance between adjacent discs is to be furnished with additional information schedule of bid proposal sheets along with procedure for checking the same.

Details of thermal stability test for uniform distribution of current on individual disc is to be furnished.

i) The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.

j) The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.

4.0 FITTINGS AND ACCESSORIES:

a) 390/198 kV Arresters shall be complete with insulating base having provision for bolting to flat surface of structure.

b) Self contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit alongwith necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

c) Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to be supplied by the Contractor.

The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. Connection between the Surge Arrester base and Surge Monitor shall be through a 2.0 m long insulated stranded cable. The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.

d) Grading/corona rings shall be provided on each complete arrester unit as required. Suitable terminal connectors shall be supplied by the Contractor.

5.0 TESTS:

5.1 The surge arresters should have been type tested as per IEC/IS and shall be subjected to routine and acceptance tests in accordance with IEC document. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020. In the switching surge operating duty test, the samples shall be pre-heated to 70 deg. C, (instead of 60 deg. C. as given in IEC) prior to application of long duration surges for contamination test procedures outlined in ANSI: 062-11-1987 may be followed until IEC brings out alternate test procedure for the same.

The test reports of the type tests and the following additional type tests shall also be submitted for the Purchaser's review.

i) Radio interference voltage test.

ii) Seismic withstand test.

iii) Contamination test.

iv) Temporary over voltage withstand test procedure to be mutually agreed

Each metal oxide block of surge arresters shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC: 60099-4.

5.2 (a) **Acceptance Tests:**

1. Measurement of power frequency reference voltage of the arrester units.
2. Lightning Impulse Residual voltage on arrester units.
3. Internal Ionisation or partial Discharge test.

(b) **Special Acceptance Test:**

1. Thermal stability test on three sections.
2. Aging & Energy Capability test on blocks (procedure to be mutually agreed).
3. Wattloss test.

(c) **Routine Tests:**

1. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e. P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).
2. Measurement of reference voltage.
3. Residual voltage test of arrester unit.
4. Internal Ionisation test or partial discharge test.
5. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) **Test on Surge Monitors:**

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100A and 10kA current impulse, (8/20 micro sec.) shall also be performed on the Surge monitor.

Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapours shall be visible on the monitor glass.

(e) **Test on insulators**

All routine tests shall be conducted on the hollow column insulators as per IEC - 233. The following additional tests shall be carried out on 420 kV, 245 kV Insulators:

i) Ultrasonic test as a routine test.
ii) Pressure test as a routine test.
iii) Bending load test in 4 directions at 50% specified bending load as a routine test.
iv) Bending load test in 4 directions at 100% specified bending load as a sample test on each lot.
v) Burst pressure test as a sample test on each lot.

6.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Contractor shall supply spare parts and maintenance equipment, as mentioned.

7.0 TECHNICAL PARAMETERS:

A. 420 kV & 220 kV CLASS SURGE ARRESTER

S. No.	Particulars	400KV LA	220KV LA
1	Manufacturer of Metal oxide elements	Please Specify	Please Specify
2	Type	Gap less type	Gap less type
3	Applicable Specification and Standards	IEC 99-4: 1991	IEC 99-4: 1991
4	Rated frequency of Arrestor	50 Hz	50 Hz
5	Applicable ambient temperature	50° C	50° C
6	Number of units per phase	2/3	2/3

S. No.	Particulars	400KV LA	220KV LA
7	Max. Continuous Operating Voltage (COV)	303 kV rms	168 kV rms
8	Rated arrester voltage	390 KV	198 KV
9	Duty for which suitable	Heavy Duty	Heavy Duty
10	Class designation	Station Class	Station Class
11	Magnitude of continuous current through arrester at the ambient temperature at COV of 303/168 KV rms. a. Capacitive b. Resistive	 1.5 0.4	 1.5 0.4
12	Nominal discharge current	10 KA of 8/20 microsec. wave	10 KA of 8/20 microsec. wave
13	High current 4/10 microsecond wave tgest valve (Kap)	125 KA peak	125 KA peak
14	Maximum residual voltage at: 1. 5 kA 1. 10 kA nominal discharge current 2. 20 kA nominal discharge current 3. Steep front wave residual volt at 10 kA	 ------ 900 kVp 975 kVp 1050 kVp	 560 kVp 600 KVp ---- 650 kVp
15	Min. switching surge residual volt.(1 kA)	730 kV	----
16	Max. switching surge residual volt.(1 kA)	780 kV	500 kVp
18	Reference current of the arrestor	3.25 mA	3.25 mA
19	Min. discharge capability (KJ/kv)	8	5
20	Long duration discharge class	III	III
21	Partial discharge at 1.05 time COV (pc)	Less than 50 pc	Less than 50 pc
22	One minute power frequency withstand voltage for full arrestor	630 kV rms	460 kV
23	1.2/ 50 microsec lightening impulse withstand voltage for full arrestor	1425 KVp	1050 KVp
24	250/2500 microsec switching impulse withstand voltage for full arrestor	1050 KVp	------
25	Details of grading rings provided	Please specify	Please specify
26	Minimum Total creepage distance	10500 mm	6125 mm
27	Pressure relief device :		
	Current for Pressure relief test.	50 KA rms.	50 KA rms.
28	Duration of flow of fault current (Seconds)	0.21 Seconds	0.21 Seconds
29	Maximum time to vent from instant of start of flow of fault current (Seconds)	0.21 seconds	0.21 seconds
30	Material of end fittings.	MS Fabricated HDG	MS Fabricated HDG
31	Weight of complete single phase arrestor	Please specify	Please specify
	1. Without insulating base	Please specify	Please specify

S. No.	Particulars	400KV LA	220KV LA
	2. With insulating base	Please specify	Please specify
32	Temporary power frequency voltage withstand capacity.		
	1. 0.1 second	580 KV rms.	233 KV rms.
	2. 1.0 second	565 KV rms.	223 KV rms.
	3. 10 seconds	550 KV rms.	213 KV rms.
	4. for 3 peaks	750 KV rms.	242 KV rms

8.0 TESTING AND COMMISSIONING

8.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor 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) Leakage current measurement.

(b) Resistance of ground connection.

****

SHUNT REACTOR

1 General:-

This specification covers design, engineering, manufacture, testing at manufacture's works, delivery at site including all materials, accessories, spares, unloading, handling, proper storageat site, erection, testing and commissioning of the equipment specified.

Type of Reactor:-

The 3 phase shunt reactor shall be of either gapped core type or magnetically shielded air coretype construction.

1.1 TECHNICAL PARMETERS OF SHUNT REACTOR & NGR:

S. No	ITEM	Specifications
1	Rated Voltage Ratio: kV	420 (1.0 p.u.)
2	**Rating of the shunt reactor**	50 MVAR
3	System fault level	50 KA
4	Connection	Star with neutral brought out
5	Insulation levels: For windings a)1.2/50 microsecond impulse withstand voltage (kVp) b)20/200/500microsecond switching surge withstand voltage (kVp) c) Power frequency withstand voltage (kV rms.)	HV Neutral 1425 550 1050 -- 630 230
6	Permissible temperature rise: Over 50deg C ambient temp . i) Of top oil measured by thermometer. ii) Of winding measured byresistance method.	 40^{0} c 45^{0} c
7	Type of cooling	Natural Oil circulation(ONAN)
8	Ratio of Zero sequence reactance to positive reactance(X0/X1)	Between 0.9 & 1.0
9	Range of constant impedance	Upto 1.5 p.u. Voltage (the bidder shall furnish complete saturation characterstics of the reactor upto 2.5 p.u. voltage
10	Harmonic content in phase current	The crest value of the third harmonic component in phase current not to exceed 3% of the crest value of the fundamental.
11	Permissible current unbalance among different phases	+2%
12	Minimum clearance in air at rated voltage of 420 KV with terminal conductor a. Phase to Phase b. Phase to ground	 4000 mm 3500 mm
13	Noise level at rated voltage and frequency	81 Db

S. No	ITEM	Specifications
14	Bushings: 1) Voltage Rating (kV rms) 2)Current Rating A 3)Insulation level: a) 1.2/50 micro sec.lightning impulse with stand voltage (kVp) b) 250/2500micro.sec.swiching impulse with stand voltage (kVp) c) 1 Minute power frequency withstand voltage (kV rms) 4) Min.Total Creepage distance (mm)	Line side / Neutral side 420 / 145 800 / 800 1425 / 650 1050 / --- 630 / 270 10500 / 3625
15	(I) Maximum Losses at rated voltage & frequency at 75 degree C (II) Minimum Losses at rated voltage & Frequency at 75 Dgree C	100 KW 90 KW
16	Impedance per phase	3528
17	Rated current in Amp	69 A
	Neutral Grounding Reactor	
1	Rated voltage from insulation strength consideration	145 kV
2	No. of phases	One
3	Frequency	50 Hz
4	Insulation	Graded
5	Max. continuous current	--- A rms
6	Rated kvar continuous	3000
7	One minute rating kvar	11250
8	Rated choke volts short time current(10 sec.)	68.92 KV
9	Rated impedance at rated short time current	- ohm (this is an indicative value)
10	Bushings: 1) Voltage Rating (kV rms) 2)Insulation level: a) 1.2/50 micro sec.lightning impulse with stand voltage (kVp) b) 1 Minute power frequency withstand voltage (kV rms) 3) Min.Total Creepage distance (mm)	Line side / Ground side 145 / 52 650 / 125 275 / 50 3625 / 1300
11	Connection	Between neutral of shunt reactor and ground
12	Insulation levels: For windings a)1.2/50 microsecond impulsewithstand voltage (kVp) b) Power frequency withstand voltage (kV rms.)	Line side / Ground side 550 / 95 230 / 50

S. No	ITEM	Specifications
13	Permissible temperature rise: Over 50deg C ambient temp . i) Of top oil measured by thermometer. ii) Of winding measured byresistance method.	 40^{0} c 45^{0} c
14	Cooling system	ONAN
15	Cooling medium	Mineral oil
16	Whether neutral is to be brought out	Yes through 36 kV class porcelain bushing
17	Method of grounding	Solidly connected between neutral of shunt reactor and earth.

S. No	ITEM	Specifications
20.	Shunt Reactor/NGR Oil.	
	1 Appearance	The oil shall be clear and transparent and free from suspended matter or sediment.
	6 Density at 27^o C max.	$0.89 g/cm^3$
	7 Kinematic viscosity max.	
	c) At 27^o C	27 cSt.
	d) Sub-zero temp.	Under consideration.
	8 Interfacial tension @ 27 degree min,	0.04N/m
	9 Flash point Penskymartn (closed) min.	140 degree centigrade
	10 Pour point max.	-10^oC
	11 Neutralization value (total acidity) max.	0.01mg. KOH /g
	12 Corrosive sulfur (in terms of classification of copper strip)	Non corrosive
	13 Electric strength (break-down voltage)	
	c) New untreated oil	30 kv (RMS) If the value is not attainted the oil shall be treated.
	d) After treatment	75 kv (rms)
	14 Dielectric dissipation factor (tan delta) at 90^o C max	0.002
	15 Specific resistance (resistivity)	
	c) At 90^o C min.	$35x10^{12}$ ohms-cm
	d) At 27^o C min.	$1500x10^{12}$ ohms-cm
	16 Oxidation stability	
	c) Neutralization value after oxidation (max)	0.20 KOH/g
	d) Total sludge after oxidation (max)	0.05 % by weight
	17 Presence of oxidation inhibitor	The oil shall not contain antioxidant additives
	14 Water content (max)	
	a.) New untreated oil	50 ppm
	b.) After treatment	10 ppm
	15. Prior to energisation at site acceptance norms.	
	a.) BDV (KVrms)	75 KV (Min.)
	b.) Moister containt	10 ppm (max.)
	c.) Tan- Delta of oil at 90 deg C	0.003 (Max.)
	d.) Resistivity at 90 deg C	$1x10^{12}$ ohms-cm (Min.)
	e.) IFT	0.03 N/m (Min.)

1.4 Non magnetic material sheet shall form the central core to minimize the vibrations. A magnetic shield shall be provided around the coreless coils.

1.5 The contractor shall dispatch & transport the reactor filled with oil or dry nitrogen gas pressure testing valve with pressure gauge and adopter valve shall be provided.

2 **Performance:-**

Shunt reactors ill be connected to the 400KV transmission line for reactive load compensation and shall be controlling the dynamic over voltage occurring in thesystem due to load rejection Shunt reactor shall be capable of operating

continuously at a voltage 5% higher than their rated voltage without exceeding hot spot temperature of 150º C at any part of the reactor.

Temperature rise shall be guaranteed when shunt reactor is operating at 420 KV.The neutral grounding reactors are required for grounding of the neutral point ofshunt reactors to limit the secondary arc current and the recovery voltage to a minimum value.

The reactors shall be subjected to switching surge overvoltage of 2.5 p.u. and temporary overvoltage of the order of 2.3 p.u. for few cycles followed by powerfrequency overvoltage up to 1.5 p.u. The reactor must withstand the stress due toabove transient dynamic conditions which may cause additional current flow as aresult of changed saturation characteristics/slope beyond 1.5 p.u. voltage.

3 Construction details :-

The feature and construction of the reactors shall be in accordance with the requirements stated hereunder.

Tank and Tank Accessories:-

3.1.1 Tank

Tank shall preferably be of welded construction and fabricated from tested quality low carbon steel of adequate thickness.Tank stiffeners shall be provided by general rigidity and these shall be designed to prevent retention of water.The shunt reactor shall preferably be bell type tank with the joint at about 500mm above the bottom of the tank. In case the joint is welded, it shall be provided with flange suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.

3.1.2 Tank cover:-

3.1.2.1 The tank cover shall preferably be sloped to prevent retention of water and shall not distort when lifted.

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

3.1.2.3 The tank cover shall be fitted with pockets at the position of maximum oil temperature at maximum continuous rating for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

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

3.1.2.5 All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over compression.

3.1.3 **Transportation of reactors**

The contractor shall dispatch the reactor in an atmosphere of nitrogen at positive pressure .Necessary arrangement shall be ensured by the contractor to take care of the pressure drop of the nitrogen during transit & storage till completion of oil filling during erection.A gas pressure testing valves with necessary pressure gauge and adaptor valve shall be provided.

Reactor shall also be fitted with electronic impact recorders (on returnable basis) during transportation to measure the moment due to impact in all three directions.The acceptance criterion & limits of impact in all three directions shall be submitted by contractor during detailed engineering.The recording shall commence in the factory before dispatch and must continue till the unit is installed on its foundation. The data

of electronic impact recorder shall be downloaded at site & a soft copy of it shall be handed over to Engineer incharge.Further within three weeks the contractor shall communicate the interpretation of the data.

3.1.3.1 The shunt reactor shall be mounted on concrete plinth foundation directly.

3.1.3.2 One complete set of flanged bi-directional wheels and axles shall be provided for each sub-station. This set of wheels and axles shall be suitable for fixing to the under carriage of shunt reactor to facilitate its movement on rail track.

3.1.3.3 The rail track gauge shall be 1676mm.

3.1.3.4 Bidder can supply one set of trolley in place of rollers for movement of shunt reactor per sub-station.

3.1.4 **Foundation and Anti Earthquake clamping Device:-**

3.1.4.1 To prevent reactor movement during earthquake, suitable a clamping device shall be provided for fixing the reactor to the foundation.

3.1.5 **Conservator & Oil Preservation System:-**

3.1.5.1 Main conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture and shall be fitted with magnetic oil level gauge with low oil level electrically insulated alarm contacts.

3.1.5.2 NGR shall have conventional type conservator with prismatic oil level gauge.

3.1.5.3 **Conservator tank**

3.1.5.3.1Conservator tank shall have adequate capacity between highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the shunt reactor and cooling equipment from minimum ambient temperature to 100º C.It shall have prismatic oil level gauge as well as MOG.

3.1.5.3.2 The conservator shall be fitted in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell, wherever applicable.

3.1.5.3.3 Conservator shall be positioned so as not to obstruct any electrical connection to reactor.

3.1.5.4 Oil Preservation Equipment:- The requirements of air cell type oil sealing system are given below.

3.1.5.4.1 **Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth air cell**.

3.1.5.4.2 The temperature of oil is likey to rise up to 100º C during operation. As such air cell used shall be suitable for operating continuously at 100º C.

3.1.5.4.3 Air cell of conservator shall be able to withstand the vacuum during installation/maintenance periods. Otherwise provision shall be kept to isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with conservator.

3.1.5.4.4 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

3.1.5.5 Dehydrating filter Breather:- Conservator shall be fitted with a dehydrating filter breather. It shall be so designed that :

a) Passage of air is through a dust filter and silicagel.

b) Silicagel is isolated from atmosphere by an oil seal.

c) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.

d) Breather is mounted not more than 1200mm above rail top level.

e) To minimize the ingress of moisture following shall be provided.

i) Three breathers (of identical size) shall be connected in series for conservator of shunt reactor. Minimum size of breather shall be 1kg per 3500 liter of oil in the reactor

ii) Two breathers (each of 2.5 litres minimum volume) shall be connected in series for NGR tank conservator.

3.1.5. **Buchholz Relay**:- A double float/reed type Buchholz relay shall be provided. All gases evolved in the reactor shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper/stainless steel tube shall be connected from the gas collector to a valve located about 1200mm above ground level to facilitate sampling with the reactor in service. The device shall be provided with two electrically independent contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

3.1.6. Temperature indicators:-

3.1.6.1 Oil Temperature Indicator (OTI):-

All shunt and neutral grounding reactors shall be provided with a 150mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts.

The maximum reading pointer and resetting device for the thermometer shall be mounted in the marshalling box. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to OTI by means of capillary tubing. Temperature indicator dials shall have linear gradations to clearly read at least every 2º C. Accuracy class of OTI shall be ± 1.5% or better.

3.1.6.2 **Winding Temperature Indicator (WTI**):-

i) Calibration device.

ii) Accuracy class of WTI shall be ±1.5% or better.

iii) In addition to the above, the following shall be provided for remote indication of winding temperature for each reactor.

a) Signal transmitter:-

Signal transmitter shall have additional facility to transmit signal for recording winding temperature at employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied.

b) Remote winding temperature indicator

3.1.6.3 **Pressure Relief Device**

Adequate number (Minimum 3 Nos.) of pressure relief devices shall be provided at suitable locations. These shall be mounted on an extended pipe section and not directly on the tank top and shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment.The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directly on the tank. One set of electrically insulated contacts shall be provided for alarm/tripping.. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank. Following routine tests shall be conducted on PRD.

1. Air pressure test
2. Liquid pressure test
3. Leakage test
4. Contact test
5. Dielectric test.

3.1.7 Earthing terminals:-

3.1.7.1.1 Two earthing terminals suitable for connection to 75x12mm galvanized steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately.

3.1.8 Core:-

3.2.1.1 In case of gapped core construction, the following requirements are stipulated.

3.2.1.1.1 The core shall be constructed from high grade, non-ageing, cold rolled, supergrain oriented, silicon steel (Hi B) laminations.

3.2.1.1.2 The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2KV rms for 1 minute.

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

3.3 Windings:-

3.3.1 The conductors shall be of electrolytic grade copper, free from scales and burrs.

3.4 Insulating Oil:-

3.4.1 The insulating oil shall conform to all parameters specified as per relevant IS/IEC.

3.5 T erminal arrangement:-

3.5.1 Bushings

3.5.2 Bushings for voltage

3.5.3 Oil filled condenser type bushings

3.5.4 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.

3.5.5 Clamps and fittings shall be of hot dip galvanized steel.

3.5.6 Terminal marking:-

3.5.7 Neutral earthing arrangement.

3.5.8 The neutral of the shunt reactor shall be brought out through 145KV class oil filled condenser bushing.

3.5.9 The neutral of shunt reactor connected to line shall be grounded through a neutral grounding reactor.

3.6 Cooling equipment.

3.6.1 Oil immersed with natural cooling (ONAN)

3.6.2 The radiator bank of the shut reactor shall be separately mounted. For neutral grounding reactor, the radiator, if required may be tank mounted.

3.6.3 Radiators shall be made from pressed steel.

3.7 Marshalling box:- The marshalling box shall accommodate the following –

a) Temperature indicator for winding and oil

b) Terminal blocks and gland plates for incoming and outgoing cables.

4. Fittings:-

4.1. Inspection and testing:-Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment.

5. Factory tests:-

5.1 Routine tests on shunt reactor as per IS 5553

a) Measurement of winding resistance
b) Measurement of insulation resistance
c) Measurement of reactance
d) Measurement of loss
e) Dielectric test
f) Induced voltage test

5.2 Switching impulse on the line terminals

5.3 Oil leakage test on reactor tank

5.4 Lightning impulse test on all phases.

5.5 Vibration and stress measurement test.

5.6 Sweep Frequency response analysis (FRA)

5.7 Routine tests on neutral grounding reactor

5.8 Routine test on bushings:- Following tests shall be conducted on bushings-

a) Test for leakage on internal filling

b) Measurement of creepage distance
c) Dry power frequency test on terminal and tapping
d) Partial discharge test followed by dielectric dissipation factor and capacitance measurement.

5.9 Partial discharge measurement test (as per IS:2026)

6. Type tests on shunt reactor:- Following type tests shall be conducted on each shunt reactor –

a) Temperature rise test
b) Measurement of zero sequence reactance
c) Measurement of acoustic noise level
d) Lighting impulse test on neutral
e) Tank vacuum and tank pressure tests
f) Measurement of knee point voltage
g) Measurement of capacitance and tan delta to determine capacitance between winding and earth.

Note : (Type test report of Snap back test on HV bushingshall be submitted. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

7 Types tests on neutral grounding reactor:- Following type tests shall be conducted on each neutral grounding reactor.

a) Impulse voltage withstand test
b) Tank vacuum and tank pressure tests on NGR tank
c) Measurement of winding resistance
d) Measurement of insulation resistance
e) Measurement of tan delta of bushing

8 Tank tests

9 Vacuum test:- Shunt and neutral grounding reactor tank shall be subjected to the specified vacuum.

10 Pressure test:- Shunt and neutral grounding reactor tank of each size its radiator, conservator vessel and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or normal pressure plus 35KV/sqm whichever is lower, measure at the base of the tank and maintained for one hour. The permanent deflection of the flat plate after the excess pressure has been released shall not exceed the figures specified above for vacuum.

11 BUSHING CURRENT TRANSFORMER:-

14.1 Current transformers shall comply with IS:2705/IEC-185

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

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

14.4 Bushing current transformer parameters indicated in this specification are tentative and liable to change within responsible limits. The contractor shall obtain employer's approval before proceeding with the design of bushing current transformers.

14.5 Purpose:- REF protection, metering, WTI

14.6 TECHNICAL PARTICULAR OF BUSHING CT

		Shunt reactor (on each phase connection)		NGR	
		Line side	Neutral side	Line side	Earth side
Ratio	Core 1	200/1	200/1	200/1	200/1
	Core 2	200/1	-----		
	Core 3	200/1	2000-1000/1A		
	Core 4	200/1	2000-1000/1A		
Minimum knee point voltage or burden and accuracy class	Core 1	200 V, PS	200 V, PS	200 V, PS	200 V, PS
	Core 2	200 V, PS	Suitable for WTI		
	Core 3	200 V, PS	1000-500- 250 V,PS		
	Core 4	10 VA ,1.0	1000-500- 250 V,PS		
Max. CT resistance	Core 1	1 ohm	1 ohm	1 ohm	1 ohm
	Core 2	1 ohm	-----		
	Core 3	1 ohm	10-5-2.5 ohm		
	Core 4	-----	10-5-2.5 ohm		
Application	Core 1	Reactor differential	Reactor differential	REF	REF
	Core 2	REF	Temp. indicator(on one phase only)		
	Core 3	Reactor back up	Line protection (Main -1/spare)		
	Core 4	Metering	Line protection (Main -II/spare		

15. Drawings/documents to be furnished by the manufacturer of Shunt Reactor/NGR

(a) Outline dimensional drawings of Reactor and its accessories including conservator complete with Bill of material and details of all parts, their quantity, rating & name of Vendors indicating clearances of Reactor body from live terminals.

(b) Drawing of Reactor tank with location of inspection windows, thickness of side/bottom/top of tank, details of stiffener.

(c) Drawing indicating limbed core construction with complete details of no., width and wt. of core laminations with size of steps; thickness of core laminations ; dimension of window; size of limbs; Gross and net core ; wt. of complete core.

(d) Drawing indicating core belting arrangement with details of belting, belting material etc.

(e) Large scale dimensioned drawings for windings of the Reactor; size and of cooling ducts, coil clamping arrangement, no./size & location of pressure screws, clamping ring; top yoke arrangement etc.

(f) Detailed drawing of Reactor tank with complete core and winding indicating clearances inside Reactor tank as also passage and space for free movement of at least two persons for inspection of active parts etc .

(g) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc. for the Reactor/radiators drawn to scale .
(h) Drawings giving the weights for foundations.
(i) Combined Rating and diagram plate including tap changing, which should also include details of guaranteed and measured losses as also winding resistances and percentage impedances.
(j) Schematic control and wiring diagram for all auxiliary equipment and control cubicle.
(k) Drawing showing constructional details, dimensions, mechanical & technical particulars of bushings. Arrangement of terminals and details of connection of bushing shall also be indicated in drawing with their technical particulars.
(l) Transportation drawing of Reactor.
(m) Details of fittings and cable box.
(n) Drawing showing arrangement and details of tap changing gear including selector switch, diverter switch and drive mechanism.
(o) Valve Schedule plate.
(p) Oil filling instruction plate for conservator fitted with Air cell breather arrangement including equalizing arrangement if any required at the time of taking full Vacuum at site.
(q) Drawing and instruction for fitting of Air Cell.
(r) Drawing of conservator indicating internal details of air cell MOG, oil level gauge and silica gel breather pipe fitting arrangement.
(s) Drawings of all Reactorbushings with complete details meeting TS requirement.
(t) Drawings of Reactorterminal connectors indicating plate thickness, no. of nut bolts with size and other details.
(u) Drawing of foldable & detachable ladder with its complete details and fitting arrangement on Reactor/conservator tank.
(v) Drawing for neutral earthing arrangement indicating voltage rating of insulators and its fitting arrangements, size of copper strips, terminal connectors etc.
(w) Detailed drawing indicating two views of all valves provided in the Reactortank.
(x) Detailed internal drawing of Reactor indicating transportation locking arrangement provided to avoid shifting of core assembly.
(y) Drawing showing weights of Reactor, cooling fan structures, FCC structures with distance from central line of transformer for casting of civil foundation for transformer and associated equipments.
(aa) Drawing of Earthing terminal box showing earthing arrangement for core, end frame, tank giving details of voltage class and current rating of terminal bushings.
(ab) Drawing indicating insulation thickness details and other arrangement provided between core assembly and bottom yoke and base of bottom of tank.
(ac) Drawing indicating details of 'O' ring gasketting arrangement provided in transformer tank covers.
(ad) Detailed Drawing of jacks.
(ae) Drawing of stiffeners provided on top, each faces/sides of tank with their number and size.
(af) Drawing indicating number, location, size of shields/ magnetic shunts and its material if provided inside the tank
(ag) Drawing indicating internal details of Reactorgiving complete details of clearances from live parts.
(ah) Drawing of internal winding termination arrangement indicating minimum clearance between core and take off lead.
(ai) Drawing for Lead termination to bottom of Bushings
(aj) Drawing for Lead termination to bottom of bushings.

(ak) Internal drawing & design of Core & Winding indicating all attachment with identification numbers, description including take-off arrangement of lead connection for Core & End frame and related Bill of Material

(al) Locking arrangement drawing for tank top cover, core & winding with complete dimension & details.

(am) Plan view of the bottom of Bell Tank for complete details of core coil resting arrangement, indicating clearly dimensional details, material of insulation, clamping arrangement with details of nuts/ bolts, clearance from all sides provided at bottom.

(an) Drawing indicating complete details, dimension & mounting arrangement of OLTC inside the tank with respect to End frame.

(ao) Drawing indicating complete details, dimensions & fixing arrangement of static end rings if used.

(ap) Other relevant drawings.

The manufacturer shall supply four (4) copies of the drawings as listed out above, which will describe the equipment in details for approval. Three sets of instruction books, operation and maintenance manuals and spare part bulletin, shall be supplied. In addition to above two sets of manuals and drawings with test certificates for each unit to be despatched as per despatch instructions.

It will be obligatory on the part of the manufacturer to ensure that the weight of core lamination, weight of copper, weight of steel, weight of Reactor tank along with fitting and accessories, quantity of oil, total weight of core plus winding after assembly, total weight of reactor and other dimension of Reactorworked out carefully. It may be noted that at the time of submission of final drawings, variation in these weights beyond the limits of (±) 5% shall not be permitted

16. SURGE ARRESTOR : 120 KV Surge arrestors as per IS:3070 (part I) and IEC-99-1 or IEC-99-4 except to the extent explicitly modified in the specification.The bidder shall offer surge arresters of gapless type without any series or shunt gap.The surge arresters shall be of heavy duty station class type. It shall be physically located between the neutral of 420KV shunt reactor (brought out at 145KV class bushing) and neutral grounding reactor and shall be electrically in parallel with the latter. The surge arrestors shall be able to withstand wind load calculated at 195Kg/sqm.

16. The surge arresters shall conform to type tests and shall be subjected to routine tests as per IEC-99.1/IEC-99.4

16.1 TECHNICAL PARAMETERS OF GAPLESS SURGE ARRESTER :

16.2	Rated arrester voltage	120KV
16.3	Rated system voltage	145 KV
16.4	Rated system frequency	50Hz
16.5	System neutral earthing	Effectively earthed
16.6	Installation	Outdoor
16.7	Nominal discharge current	10KA of 8/20 microsec wave
16.8	Class of arrester	10KA heavy duty type
16.9	Minimum discharge current	3.5KJ/KV(referred to rated voltage)
16.10	Continuous operating voltage	102 KVAt 50º C
	Max. switching surge	280KVP
	Residual voltage(1KA)	
16.11	Max. residual voltage at	
	i) 5 KA	320KVP
	ii) 10KA nominal discharge current	340KVP

16.12	Long duration discharge	2 class
16.13	High current short duration	100KVP
16.14	Current for pressure relief	50KArms test
16.15	Low current long duration	1000 Apeaktest value(2000 microsec.)
16.16	Min. total creepage distance	3625 mm
16.17	One minute dry power frequency withstand Voltage of arrester housing	275KVrms
17.18	Impulse withstand voltage of arrester Housing with 1.2/50 microsec. Wave	+650KVP
17.19	Pressure relief class	A
17.20	RIV at 921:Vrms	Less than 500microvolts
17.21	Partial discharge at 1.05 continuous over Voltage	not more than 50pC
17.22	Seismic acceleration	0.3 g horizontal
17.23	Reference ambient temperature	50º C

TECIINICAL PARAMETERS FOR 72.5 kV EQUIPMENTS

A. 72.5 kV SF6 CIRCUITBREAKER

1	Rated continuous current (A) at design ambient temperature of 50°C	1250
2	Rated short circuit current breaking capacity at rated voltage	25kA with percentage DC component as per IEC 62271-100 corresponding to minimum opening time under operating conditions specified.
3	Highest System Voltage	72.5 KV
4	Rated Short duration power frequency withstand voltage	140 KV
5	1.2/50 micro sec lightening impulse withstand voltage	325 KV
6	Symmetrical interrupting capability kA **(rms)**	25
7	Rated short circuit making current kA (peak)	63
8	Short time current carrying capability for one second kA (rms)	25
9	Rated line charging interrupting current at 90° leading power factor angle (A **rms)**(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of I.J/23 and 1.4 as per IEC 62271-100	As per IEC
10	Maximum allowable switching over voltage under any switching condition	As per IEC
11	Total break time. (ms)	**Less** than 40
12	'Total closing time (ms)	Not more than 100
13	Rated operating duty	0-0.3S-CO-3min-CO Cycle
14	Operating mechanism	Spring
15	Trip coil and closing coil voltage	220V DC
16	Auxiliary contacts	Besides requirement of Technical specification, the contractor shall wire up 2 NO + 2 NC contacts for future use
17	Noise level at base and upto 50 m distancefrom base ofreaker	140 dB (Max.)
18	Rated terminal load	As per IEC
19	Temperature rise over the design ambient temperature	As per IEC 60694
20	First pole **to** clear factor	1.5
21	No. of terminals in common	All contacts & control circuits to be wired out

	control cabinet	too common control cabinet plus 10 Terminals exclusively for owner use.

B.72.5 kV CURRENT TRANSFORMERS

1	Rated Primary current	a)50-25/1-1-1 A (b)1000-500/1-1-1-1A
2	Rated extended current	120%
3	Highest System Voltage	72.5 KV
4	Rated Short duration power frequency withstand voltage	140 KV
5	1.2/ 50 microsec lightening impulse withstand voltage	325 KV
6	Rated short time current	25 kA for 1 sec.
7	Rated dynamic current	63 kAp
8	Maximum temperature rise over design ambient temperature	As per IEC-60044-1
9	One minute power frequency withstand voltage sec. terminal & earth	5 kV **(rms)**
10	Number of terminals	All terminals of control circuits arc to be wired upto marshalling box plus 20% spare terminals evenly distributed on all TB **s.**
11	Type of insulation	Class A
12	Primary & Secondary Winding	Electrolytic Copper.
		The primary stud shall be minimum 110mm long and dia of the stud shall be 60 mm

C.72.5 kV VOLTAGE TRANSFORMERS

1	System Fault level	25kA for 1 second
2	Standard reference range of frequencies for which the accuracies	96% to 102% for protection and 99.5 to 101% for measurement
3	Highest System Voltage	72.5 KV
4	Primary & Secondary Winding	Electrolytic Copper
5	Rated Short duration power frequency withstand voltage	140 KV
6	1.2/ 50 microsec lightening impulse withstand voltage	325 KV
7	One minute power frequency withstand voltage for secondary	3kV (rms)
8	Maximum temperature rise over design ambient temperature	As per **IEC:186**
9	Primary & Secondary Winding	Electrolytic Copper. The primary stud shall be minimum 110mm long and dia of the stud shall be 60 mm

(A) 72.5 kV ISOLATOR

1.	Rated voltage	72.5 kV
2.	Rated current	1200 A
3.	Standards	IEC 129
4.	Rated short time withstand (in KA)	25KA for 1 sec.
5.	Operating drive	AC Motor operated
6.	Type	Double break Isolator without E/S, 3 pole, outdoor, Gang operated
7.	Interlock	Mechanical pad lock to be provided to ensure no unauthorized operation
8.	Construction details	All ferrous parts to be galvanized except nuts and bolts which shall be electroplated as per relevant IS
9.	Current carrying components	Shall be copper. The current density shall not be more than 1A/mm sq.
10.	Terminal connector	As per specification mentioned elsewhere in the tender document

ADDITIONAL REQUIREMENTS OF 72.5 kV VOLTAGE TRANSFORMER

1	Rated primary voltage (kV rms)	72.5	
2	Type	Single phase Electro-magnetic	
3	**No. of** secondaries	2	
4	Rated Voltage Factor	1.2 continuous 1.5 – 30 seconds	
5	Phase angle error	+ 20 minutes (For metering core)	
6		**Secondary I**	**Secondary II**
7	Voltage ratio	33/ /3 KV/ 110v/_/3	3/_/3 KV/ 110V/ /3
8	Application	Protection	Metering
9	Accuracy	5P	0.2
10.	Output Burden (VA) (minimum)	50	50

REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER FOR STN XMER ON EXTERNAL SOURCE.

No. of Cores	Core No.	Application	Current Ratio	Output burden (VA)	Accuracy class as per IEC 44-1
3	1	Metering	50-25/1	20	0.2
	2	0/C &E/F	50-25/1	10	5P10
	3	Spare	50-25/1	10	PS

REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER STN XMER ON TERTIARY.

No. o f Cores	Core No.	Application	Current Ratio	Output burden (VA)	Accuracy class as perIEC 44-1
4	1	Metering	1000/1A	20	0.2S
	2	O/C &E/F	1000/1A	30	PS
	3	Differential relay	1000/1A	----	PS
	4	Differential relay	1000/1 A		PS

SWITCHYARD ERECTION

1.0 **GENERAL**

The detailed scope of work includes design, engineering, manufacture, testing at works, supply at site ,handling, storage, erection testing and commissioning of various items and works as detailed herein.

This section covers the description of the following items.

A- Supply of

- String insulators and hardware
- ACSR conductor
- Galvanised Steel Earth wire
- Aluminum Tubular Bus Bars
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

B. <u>Erection Of all items</u>

1.1 **String Insulators & Hardware**

The insulators for suspension and tension strings shall conform to IEC60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486.

1.2 **Construction Features**

Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength markings on porcelain printed and applied before firing.

Porcelain used in insulator manufacture 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.

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

The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn99.95 as per IS-209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

Clamps for insulator strings and Corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.

Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

The tension Insulator hardware assembly shall be designed for 11500 kg tensile load. Earth wire tension clamp shall be designed for 1000 kg tensile load with a factor of safety of two (2).

The tension string assemblies shall be supplied alongwith suitable turn buckle. Sag compensation springs if required may also be provided.
All hardware shall be bolted type.

1.3 **Tests**

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

1.3.1 **Type Tests on Insulator Strings :** The test reports for following type tests hall be submitted for approval. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

a) Power frequency voltage withstand test with corona control rings under wet condition as per IEC 60383.

b) Switching surge voltage withstand test [400 kV class only] under wet condition as per IEC-60383.

c) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383

d) Voltage distribution test (Dry)
The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 9% and 10% for 400KV suspension string and tension insulator string respectively, 13% for 220KV suspension and tension insulator strings, respectively.

e) Corona Extinction Voltage test (Dry)
The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320kV(rms) for 400kV and 156kV(rms) for 220kV line to ground under dry condition. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

f) RIV Test (Dry)
Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage level below 1000 microvolts at 1 MHz when subjected to 50 Hz AC line to ground voltage of 320kV for 400kV and 156kV for 220kV string under dry conditions. The test procedure shall be in accordance with IS 8263/IEC 60437.

g) Mechanical strength test
The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotterpins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.3.2 **Type Tests on Insulators**

Type test report for Thermal Mechanical Performance shall be submitted for approval.

1.3.3 **Acceptance Tests for Insulators:**

a) Visual examination as per IEC 60383
b) Verification of Dimensions as per IEC 60383.
c) Temperature cycle test as per IEC 60383.
d) Puncture Test as per IEC 60383.
e) Galvanizing Test as per IEC 60383.
f) Mechanical performance test as per IEC-60575 Cl. 4.
g) Test on locking device for ball and socket coupling as per IEC-60372(2)
h) Porosity test as per IEC 60383.
i) Thermo mechanical test as per IEC 60383

1.3.4 **Acceptance Test on Hardware Fitting**

a) Visual Examination as per Cl. 5.10 of IS:2486 (Part-I).
b) Verification of Dimensions as per Cl. 5.8 of IS : 2486 (Part-I)
c) Galvanising/Electroplating tests as per Cl. 5.9 of IS : 2486 (Part-I).
d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)
e) Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the Bidder).
f) Mechanical strength test for each component (including corona control rings and arcing horns).
g) Test on locking devices for ball and socket coupling as per IEC: 60372(2).

1.3.5 **Routine Test on Insulator**

a) Visual Inspection as per IEC60383
b) Mechanical Routine Test as per IEC60383
c) Electrical Routine Test as per IEC60383

1.3.6 **Routine Test on hardware Fittings**

a) Visual examination as per Cl 5.10 of IS : 2486 (Part-I).
b) Mechanical strength Test as per Cl. 5.11 of IS : 2486 (Part-I).

1.3.7 **Test during manufacture on all Components as applicable on insulator**

a) Chemical analysis of zinc used for galvanising:
Samples taken from the zinc ingot shall be chemically analyzed as per IS : 209. The purity of zinc shall not be less than 99.95%.
b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:
The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.

1.3.8 Test during manufacture on all components as applicable on hardware fittings:

a) Chemical analysis of zinc used for galvanising:
Samples taken from the zinc ingot shall be chemically analyzed as per IS : 209. The purity of zinc shall not be less than 99.95%
b) Chemical analysis, hardness tests and magnetic particle for forgings:

The chemical analysis, hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

c) Chemical analysis and mechanical hardness tests and magnetic particle inspection for fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance programme.

1.4 **Parameters**

1.4.1 **Disc Insulators**

400/220kV

a)	**Type of insulators**	**:**	**Anti Fog type**
b)	Size of insulator units (mm)	:	255x145
c)	Electro mechanical strength	:	160 kN
d)	Creepage distance of individual insulator units (minimum and as required to meet total creepage distance)	:	430 mm
e)	Markings	:	Markings on porcelain shall be printed and applied before firing
f)	Power frequency puncture withstand voltage	:	1.3 times the actual wet flashover voltage.

1.14.2 **INSULATOR STRING**

			400 kV	**220kV**
a)	Power frequency withstand voltage of the complete string with Corona Control ring (wet) - kV rms	:	680	460
b)	Lightning impulse withstand Voltage of string with corona control rings (dry) - kVp	:	± 1550	+ 1050
c)	Switching surge withstand voltage of string with corona control rings (wet) - kVp	:	± 1050	NA
d)	Minimum corona extinction	:	320- kV rms	156
e)	RIV level in micro volts of string: with Corona Control(Max.) rings at 320 kV (rms) for 400 kV string and 156 kV for 220 kV string across 300 Ohms resistor at 1 MHz		1000 (Max.)	1000
f)	Min creepage of insulator string (mm)		10500	6125

g) Total no. of discs per strings : 25 15

For tension application, double insulator strings and for suspension purpose single suspension insulator string shall be used for 400 KV, 220 KV system.

2.0 ACSR 'MOOSE' CONDUCTOR

2.1 Details of Conductor

2.1.1 The Conductor shall conform to IS:398 (Part V) - 1982 except where otherwise specified herein.

2.1.2 The details of the conductor are tabulated below:

a) Stranding and wire diameter : 54/3.53 mm Al+7/3.53mm Steel

b) Number of Strands

Steel centre : 1

1st Steel Layer : 6

1st Aluminium layer : 12

2nd Aluminium Layer : 18

3rd Aluminium Layer : 24

c) Sectional area of aluminium 528.5 mm2

d) Total sectional area 597.00 mm2

e) Overall diameter 31.77 mm

f) Approx. weight 2004 kg/km

g) Calculated d.c. resistance at 20 deg C : 0.05552 ohm/km

h) Minimum UTS 161.2 kN

2.1.3 **The details of aluminium strand are as follows:**

i) Minimum breaking load kN of strand before stranding : 1.57

ii) Minimum breaking load kN of strand after stranding : 1.49

iii) Maximum D.C. resitance Ohms/Kmof strand at 20oC. : 2.921

2.1.4 **The details of steel strand are as follows:**

i) Minimum breaking load of strand before stranding 12.86 kN

ii) Minimum breaking load of strand after stranding : 12.22 kN

iii) Minimum number of twist to be with stood in torsion test when tested on a gauge length of 100 times diameter of wire : 18 - before stranding 16 - after stranding

2.2 Workmanship

2.2.1 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating of 260 gm/sq.m. after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips after stranding in standard Preece test. The finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation : B 498-74.

2.3 **Joints in Wires**

2.3.1 **Aluminium Wires**

No joints shall, be permitted in the individual wires in the outermost layer of the finished conductor. However, joints in the 12 wire and 18 wire inner layers of the conductor shall be allowed but these joints shall be made by cold pressure butt welding and shall be such that no such joints are within 15 metres of each other in the complete stranded conductor.

2.3.2 **Steel Wires**

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand splices in any length of the completed stranded steel core of the conductor.

2.4 **Tolerances**

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

a) Diameter of Aluminium and steel strands:

	Standard	Maximum	Min.
Aluminium	3.53 mm	3.55 mm	3.51 mm
Steel	3.53 mm	3.60 mm	3.46 mm

b) Lay ratio of Conductor:

		Maximum	Min.
Steel	6 wire layer	18	16
Aluminium	12 wire layer	14	12
	18 wire layer	13	11
	24 wire layer	12	10

2.5 **Materials**

2.5.1 **Aluminium**

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%.

2.5.2 **Steel**

The steel wire strands shall be drawn from high carbon steel wire rods and shall conform to the following chemical composition:

Element - % Composition
Carbon - 0.50 to 0.85
Manganese - 0.50 to 1.10
Phosphorous - not more than 0.035
Sulphur - not more than 0.045
Silicon - 0.10 to 0.35

2.5.3 **Zinc**

The Zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS:209-1979.

2.6 **Standard Length**

2.6.1 **The Conductor shall be supplied in standard length of 1500 / 1800 metres as required.No joint shall be allowed within a single span of stringing.**

2.7 **Tests :**

2.7.1 The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

2.7.2 **Type Tests**

In accordance with the stipulation of specification, the following type tests reports of the conductor shall be submitted for approval . The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

a) UTS test on stranded conductor.

b) Corona extinction voltage test (dry)Radio Interference voltage test (dry)

(c) DC resistance test on stranded conductor

2.7.3 **Acceptance Tests**

a) Visual check for joints, scratches etc. and lengths of conductor

b) Dimensional check on steel and aluminium strands

c) Check for lay ratios of various layers

d) Galvanising test on steel strands

e) Torsion and Elongation test on steel strands

f) Breaking load test on steel and aluminium strands

g) Wrap test on steel and aluminium strands) IS:398 (Part V) 1982) Clauses 12.5.2, 12.7) & 12.8

h) DC resistance test on aluminium strands

i) UTS test on welded joint of aluminium strands

NOTE: All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.

2.7.4 **Routine Tests**

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc. on the strands.

c) All acceptance test as mentioned in Clause 2.7.3 above to be carried out on each coil.

2.7.5 **Tests During Manufacture**

a) Chemical analysis of zinc used for galvanising

b) Chemical analysis of aluminium used for making aluminium strands)

2.7.6 **Sample Batch for Type Testing**

The Contractor shall offer material for selection of samples for type testing, only after getting quality assurance plans approved from Owner's Quality Assurance Department. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Owner.

3.0 GALVANISED STEEL EARTH WIRE

3.1 Details of Earthwire

3.1.1 The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IS : 398 (Part-II)-1976 except where otherwise specified herein.

3.1.2 The details of the earth wire are tabulated below:

a) Stranding and wire steel diameter : 7/3.66 mm

b) Number of strands

Steel core	:	1
Outer Steel Layer	:	6
Total sectional area	:	73.65 mm2
Overall diameter	:	10.98 mm
Approximate weight	:	583 kg/km
Calculated d.c. resistance at 20^oC	:	2.5 ohms/km
Minimum ultimate tensile strength	:	68.4 kN
Direction of lay of outer layer	:	Right hand

3.2 WORKMANSHIP

3.2.1 The steel strands shall be hot dip galvanised (and shall have a minimum zinc coating of 275 gms/sq.m.) after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics in ASTM designation B498-74.

3.3 JOINTS IN WIRES

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

3.4 TOLERANCES

The manufacturing tolerances to the extent of the following limits only shall be permitted in the Diameter of the individual steel strands and lay length of the earth wire:

	Standard	Maximum	Minimum
Diameter	3.66 mm	3.75 mm	3.57 mm
Lay length	181 mm	198 mm	165 mm

3.5 **MATERIALS**

3.5.1 **Steel**

The steel wire strands shall be drawn from high carbon steel rodes and shall conform to the following requirements as to the chemical composition :

Element	% Composition
Carbon	Not more than 0.55
Manganese	0.4 to 0.9
Phosphorous	Not more than 0.04
Sulphur	Not more than 0.04
Silicon	0.15 to 0.35

3.5.2 **Zinc**

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS:209-1979.

3.6 **STANDARD LENGTH**

3.6.1 The earthwire shall be supplied in standard drum length of manufacturer.

3.7 **TESTS**

3.7.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

3.7.2 **TYPE TESTS**

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval .

3.7.4 **ROUTINE TESTS**

a) Check that there are no cuts, fins etc. on the strands.
b) Check for correctness of stranding.

3.7.5 **TESTS DURING MANUFACTURE**

a) Chemical analysis of zinc used for galvanising)
b) Chemical analysis of steel)

3.7.6 **SAMPLE BATCH FOR TYPE TESTING**

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance programme approved by the Owner. The samples for type testing shall be manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.

4.0 **TUBULAR BUS CONDUCTORS**

4.1 **General**

Aluminium used shall be grade 63401 WP(range 2) conforming toIS:5082. 4.2 **Constructional Features**

4.2.1 For outside diameter (OD) & thickness of the tube there shall be no minus tolerance, other requirements being as per IS : 2678 and IS: 2673.

4.2.2 The aluminium tube shall be supplied in suitable cut length to minimize wastage.

4.2.3 The welding of aluminium tube shall be done by the qualified welders duly approved by the owner.

4.3 **Tests**

In accordance with stipulations of the specification, Routine tests shall be conducted on tubular bus conductors as per IS : 5082. Also the wall thickness and quality of the tube shall be measured by the ultrasonic method. In addition to the above tests, 0.2% proof tests on both parent metal and Aluminium tube after welding shall be conducted.

4.4 **Parameters**

a) Size 4"IPS (EH Type)
b) Outer diameter(mm) 114.2
c) Thickness (mm) 8.51
d) Cross-sectional area(sq.mm) 2825.61
e) Weight (kg/m) 7.7

5.0 SPECIFICATIONS OF CLAMPS, CONNECTORS AND SPACERS:

The drawing & Samples of Clamps, Connectors & Spacers shall be got approved by CSPTCL before use in the sub station. It should be noted that the requirement is for a minimum of 100 m.m. coverage of the conductor inside the clamp for all clamps. The pad clamp shall have SIX bolts and T clamp shall have 12 bolts. For all other types of clamps the drawings shall be got approved by the contractor.

All the clamps on the conductor side should preferably be of compressed joint type and not bolted type.

At high altitude locations i.e. droppers on HV and LV side of transformer as also for 400 KV/220 KV line take off either the T clamp should be reignforced by a set of PG clamp as shown below point.

The nuts & bolts used in the clamps shall be fine machined screws of reputed make, so that the screws do not become loose during service. Nuts & bolts should be hot dipped galvanized.

For power transformer/shunt reactor bushing clamps where an aluminium conductor has to be connected to a copper stud-two separate clamps, one of Copper & other of Aluminium shall be provided with bi-metallic strip joint on the plain pad surfaces of both clamps.

Clamp Materials:-

The clamps and the connectors shall be made of materials listed below:-

a) For connection ACSR conductors Aluminium alloy casting conforming to designation LM-6 of IS-617. Sand casting is not permitted.

b) For connecting equipment terminals made of Copper or Brass & ACSR conductor, Bi-metallic connectors made from Aluminium Alloy casting conforming to designation A6 of IS 617 with 2 mm thick cast copper shall be used (for C.T. & P.T. clamps). Clamps for connecting GI shield shall be of malleable Iron casting. Nuts & bolts should be hot dipped galvanized.

TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only. Terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as

per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 150% of the maximum current carrying capacity of the ACSR conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

TESTS:

Type Tests :

It is essential to furnish following type test reports in respect of Clamps as stipulated in latest version of IS: 5561: The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

i. Tensile Test
ii. Resistance Test
iii. Temperature rise Test
iv. Short time current Test
v. Dimensional Check
vi. Galvanizing Test, if applicable

Acceptance and Routine Tests :

For Clamps & Connectors following Acceptance & Routine tests shall be conducted:

(A) Acceptance test :

i. Visual check
ii. Tensile Test
iii. Resistance Test
iv. Dimensional Check
v. Galvanizing Test, if applicable

(B) Routine Test :

i. Visual inspection
ii. Dimensional Check.

6.0 SPACERS

6.1 General

Spacers shall conform to IS : 10162. The spacers are to be located at a suitable spacing to limit the short circuit forces as per IEC 865, necessary spacer span

calculation shall be provided by the contractor during detailed engineering for the approval of Owner.

6.2 **Constructional Features**

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

6.2.2 Spacer design shall be made to take care of fixing and removing during installation and maintenance.

6.2.3 The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

6.3 **Tests**

Each type of spacers shall be subjected to the following type tests, acceptance tests and routine tests:

6.3.1 Type Tests : Following type test reports shall be submitted for approval.

a) **Clamp slip tests**

The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2 kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests shall be performed on the other clamps of the same sample.

b) Fault current test as per Cl 5.14.2 of IS : 10162

c) Corona Extinction Voltage Test (Dry).
This test shall be performed on 400 kV and 220 kV equipment as per procedure mentioned at Annexure - C, Minimum Corona Extinction voltage shall be 320 kV (rms) line to ground and 156 kV (rms) line to ground for 400 kV and 220 kV spacers respectively.

d) RIV Test (Dry)
This test shall be performed as per procedure mentioned at Annexure - C, Maximum RIV level at 305 kV (rms) line to ground and 156 kV (rms) line to ground for 400 kV and 220 kV spacers respectively shall be 1000 micro volts, across 300 ohm resistor at 1 MHz

e) Resilience test (if applicable)

f) Tension Test

g) Log decremant test (if applicable)

h) Compression test

i) Galvanising test

6.3.2 **Acceptance Test (As per IS : 10162)**

a) Visual examination
b) Dimensional verification
c) Movement test
d) Clamp slip test
e) Clamp bolt torque test (if applicable)
f) Assembly torque test
g) Compression test
h) Tension test
i) Galvanising test
j) Hardness test for neoprene (if applicable)
The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.
k) Ultimate Tensile Strength Test

The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. mm.

6.3.3 **Routine test**

a) Visual examination
b) Dimensional verification

7.0 **BUS POST INSULATORS**

The post insulators shall conform in general to latest IS : 2544, IEC-168 and IEC-815.

7.1 **Constructional Features**

7.1.1 Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

7.1.2 Porcelain used shall be homogeneous, free from lamination, cavities andother flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

7.1.3 Glazing of the porcelain shall be of uniform brown in colour, free fromblisters, burrs and other similar defects.

7.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-815 for the specified pollution level.

7.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.

7.1.6 The design of the insulators shall be such that stresses due to expansionand contraction in any part of the insulator shall not lead to deterioration.

7.1.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS: 2633, & IS: 2629. The zinc used for galvanising shall be grade Zn 99.95 as per IS : 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.

7.1.8 a) Every bolt shall be provided with a steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.

b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the bevelled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

c) All bolts and nuts shall be of steel with well formed hexagonal heads forged from the solid and shall be hot dip galvanised. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

7.2 **Tests**

In accordance with the stipulations of the specification, the post insulators shall be subject to type, acceptance, sample and routine tests as per IS : 2544 and IEC-168.

7.2.1 In addition to acceptance/sample/routine tests as per IS : 2544 and IEC- 168, the following tests shall also be carried out.

a) Ultrasonic test as an acceptance test
b) Soundness test, metallurgical tests and magnetic test on MCI caps and pedestal tests as acceptance test.

c) All hot dip galvanised components shall be subject to check for uniformity of thickness and weight of zinc coating on sample basis.

d) The bending test shall be carried out at 50% minimum failing load in four directions as a routine test and at 100% minimum failing load in four directions as an acceptance test.

e) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

7.2.2 In accordance with the stipulation of specification, the type tests reports of the post insulators shall be submitted for approval . The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

7.3 **Technical Parameters of Bus Post Insulators**

	Type	Solid Core	Solid Core
a	Voltage class (kV)	420	245
b	Dry and wet one minute power frequency withstand voltage (kV rms)	680	460
c	Dry lightning impulse withstand Voltage (kVp)	±1550	+ 1050
d	Wet switching surge withstand voltage (kVp)	±1050	—-
e	Max. radio interferencevoltage (in microvolts)at voltage of 305 kV (rms) and 156 (rms) for 400 kV & 220 KV	500	500
f	220 kV respectively between phase to ground.		
g	Corona extinction voltage(kV rms)	320 (Min.)	156 (Min.)
h	Total minimum cantilever strength (Kg)	800	800
i	Minimum torsional moment	-----	As per IEC-273
j	Total height of insulator (mm)	3350	2300
k	P.C.D Top (mm) Bottom (mm)	 127 300	 127 254
l	No. of bolts Top Bottom	 4 8	 4 8
m	Diameter of bolt/holes (mm) Top Bottom dia	 M16 18	 M16 18
n	Pollution level as perIEC-815	Heavy (III)	Heavy (III)
o	Minimum total creepagedistance for Heavy Pollution (mm)	10500	6125

7.3.1 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor.

8.0 **EARTHING** - The existing earth mat of 220/132 KV S/s was designed for system fault level of 50 KA. The same earth mat will be interconnected with new earth mat designed for new switchyard of 400/220 KV S/s Dhardehi. The complete interconnected earthmat design shall be safe for integrated 400/220/132 KV substation

8.1 The earthing shall be done in accordance with requirements given hereunder. **The earth mat design shall be done by the Contractor for 50 KA for 1 second fault level as per IEEE-80 and the same shall be submitted to CSPTCL for approval. However, a spacing of max. 7m x 7m is to be ensured as indicated in the switchyard earthmat layout enclosed with the tender. The soil resistivity measurement shall be done by the Contractor the earth mat can be closer and denser than 7mx7m if earth resistivity computation of the substation soil so demands.** The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the resistivity value of stone considered in earth mat design. For measurement purpose, one sample of stones from each source (in case stones are supplied from more than one source) shall be used. The main earth mat shall be laid in the switchyard area in accordance with the approved design requirements.

8.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

8.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

a) Code of practice for Earthing IS:3043
b) Code of practice for the protection of Building and allied structures against lightning IS:2309.
c) Indian Electricity Rules 1956 with latest amendments.
d) National Electricity Safety code IEEE-80.

8.4 **Details of Earthing System**

Item	Size	Material
a) Main Earthing Conductor to be buried in ground	40mm dia rod	Mild Steel
b) Conductor above ground & earthing leads (for equipment)	75x12mm G.S. flat	Galvanised Steel
c) Conductor above ground & earthing leads (for columns & aux. structures)	75x12mm G.S. flat	Galvanised Steel
d) Earthing of indoor LT panels, Control panels and out door marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc.	50x6 mm G.S. flat	Galvanised Steel

e)	Rod Earth Electrode	40mm dia, 3000mm long	Mild Steel
	Pipe Earth Electrode	4x100mm dia, 3000mm long	Galvanised steel
	Earthing for motors	25x3mm GS flat	Galvanised steel
h)	Earthing conductor along outdoor cable trenches	50x6mm MS flat	Mild steel
I)	Earthing of Lighting Poles	25 mm dia 3000 mm long	mild steel rod

The sizes of the earthing conductor indicated above are the minimum sizes.

8.5 **Earthing Conductor Layout**

8.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.

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

8.5.3 Tap-connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure as per "Earthing Details"..

8.5.4 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc., galvanised iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

8.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.

8.5.6 Earthing conductors crossing the road shall be laid 300 mm below road or at greater depth to suit the site conditions.

8.5.7 Earthing conductors embedded in the concrete shall have approximately 50mm concrete cover.

8.6 **Equipment and Structure Earthing**

8.6.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Owner.

8.6.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.

8.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

8.6.4 Metallic conduits shall not be used as earth continuity conductor.

8.6.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

8.6.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which inturn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.

8.6.7 Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.

8.6.8 **Earthing conductor shall be buried 5 meters outside the switchyard fence.**All the gates and every alternate post of the fence shall be connected to earthing grid.

The criterion for stone spreading shall be followed in line with requirement specified elsewhere in the specification

8.6.9 Flexible earthing connectors shall be provided for the moving parts.

8.6.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules

8.6.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.

8.6.12 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.

8.6.13 A 40 mm dia , 3000 mm long MS earth electrode with test link , CI frame and cover shall be provided to connect down conductor of lightning mast and down conductor of towers with peak.

8.7 Jointing

8.7.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. TWO bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.

8.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.

8.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

8.7.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

8.7.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before put- ting any load on it. Artificial cooling shall not be allowed.

8.7.6 Bending of earthing rod shall be done preferably by gas heating.

8.7.7 All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.

8.7.8 The 75x12mm GS flat shall be clamped with the equipment support structures at 1000mm interval.

8.8 Power Cable Earthing

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

8.9 **Specific Requirement for Earthing Systems**

8.9.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to four pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points. Size of earth pit shall be 1.5m x 1.5 m x 3 m & pipe length shall be 3mtr.

a. 2 nos. earth pits for each 315 MVA transformer neutral.
b. 1 no earth pit for each NGR

8.9.2 Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to two electrodes (as per IS) which in turn, shall be connected to station earthing grid.

8.9.3 Auxiliary earthing mat comprising of 40mm dia M.S. rods closelyspaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat.

The detailed drawing of structure earthing is provided in Annexure C

8.9.4 EARTHING CONDUCTORS

All earthing conductors buried in earth and concrete shall be of mild steel. All conductors above ground level and earthing leads shall be of galvanised steel, except for cable trench earthing. The earth mat design shall be designed for a fault level of 50 KA for one second.

Constructional Features

8.9.4.1 **Galvanised Steel**

a) Steel conductors above ground level shall be galvanised according to IS:2629.
b) The minimum weight of the zinc coating shall be 618 gm/sq. m. and minimum thickness shall be 85 microns.
c) The galvanised surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surfaces of steel. The finished surface shall be clean and smooth and shall be free fromdefects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, 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.

Tests

In accordance with stipulations of the specifications galvanised steel shall be subjected to four one minute dips in copper sulphate solution as per IS : 2633.

9.0 **Main Bus Bars**

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification.

9.1 The Contractor shall furnish supporting calculations for the busbars/conductors to show adequacy of design parameters for:

a) Fibre-stress
b) Cantilever strength of post insulators
c) Aeoline vibrations
d) Vertical deflection of bus bars

e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

9.1.1 The welds in the aluminium tubes shall be kept to the minimum and there shall not be more than one weld per span.The procedure and details of welding shall be subject to Owner's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length.The procedure and details of bending of tubes shall be subject to Owner's approval.

9.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminium alloy similar to that of clamps &connectors.

9.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

10.0 BAY EQUIPMENT

10.1 The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

10.2 **Bay Marshalling Kiosks (BMK)**:-

One no. of bay marshalling kiosk shall be provided for each 400 KV dia and one no BMK for every 220 KV bays.Inaddition to the requirements specified elsewhere in the specification, the bay marshalling room shall have three distinct compartments for the following purpose:-

(i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum six outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

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

(iii) 50nos.terminal blocks in vertical formation as spare.

(iv) CFL illumination and spaceheater in the kiosk

11.0 LIGHTNING PROTECTION

11.1 Direct stroke lightning protection (DSLP) shall be provided in the EHV switchyard through shield wires. The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLP calculations.

11.2 The lightning protection system shall not be in direct contact with underground metallic service ducts.

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

11.4 Down conductors shall be cleated on the structures at 2000 mm interval.

11.5 Connection between each down conductor and rod electrodes shall be via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earthmat.

11.6 Lightning conductors shall not pass through or run inside G.I. conduits.

12.0 EQUIPMENT ERECTION DETAILS

12.1 For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After

cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and thesurfaces shall be cleaned properly after equipment interconnection.

12.2 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators .

12.3 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

12.4 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

12.5 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

13.0 **STORAGE**

13.1 The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/CSPTCL shall be strictly adhered to.

14.0 **CABLING MATERIAL**

14.1 **CABLE TAGS AND MARKERS**

14.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

14.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.The tag shall carry details of end terminal equipments in addition to cable numbers.

14.1.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.

14.1.4 Location of underground cable joints shall be indicated with cable marker with an additional inscription “Cable joints”.

14.1.5 The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

14.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

14.2 **Cable Supports and Cable Tray Mounting Arrangements**

14.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

14.2.2 The supports shall be fabricated from standard structural steel members.

14.2.3 Insert Angles of suitable size will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.

14.3 **Cable Termination and Connections**

14.3.1 The work shall include all clamping, fittings, fixing, plumbing, soldering,drilling, cutting, taping, heat shrinking (where applicable), connecting to cable

14.4 **Storage and handling of Cable Drums**

15.0 **DIRECTLY BURIED CABLES**

15.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding of 75 mm, soil cover on sides, supply of brick and installation of brickprotective covers on top, back filling and ramming, supply and installation of route markers and joint markers. The Bidder shall ascertain the soil conditions prevailing at site, before submitting the bid.

15.2 The power cable for lighting purpose around the roads shall be laid in the buried cable trenches.

15.3 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker.

16.0 **INSTALLATION OF CABLES**

16.1 Cabling shall be done on perforated type cable trays.

16.2 All cables from bay cable trench to equipments including and all interpole cables (both power and control) for all equipment, shall be laid in GI/CI pipes of specified nominal outside diameter which shall be buried in the ground at a depth of 300mm below finish formation level. Separate GI/CI pipes shall be laid for control and power cables.

16.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all thesecases necessary bending radius as recommended by the cable manufacturer shall be maintained.

16.4 Cable supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.

16.5 Suitable arrangement should be used between fixed pipe / cable trays and equipment terminal boxes, where vibration is anticipated.

16.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

a) Power cables on top tiers.
b) Control instrumentation and other service cables in bottom tiers.

16.7 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables.

16.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon -6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.

16.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with deinterlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.

16.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows :

Table of Cable and	Minimum bending radius
Power cable	12 D
Control cable	10 D

D is overall diameter of cable

16.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth.

16.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

16.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings.

16.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

16.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by CSPTCL.

16.16 Rollers shall be used at intervals of about two metres while pulling cables.

16.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.

16.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.

16.19 Inspection on receipt, unloading and handling of cables shall generally bein accordance with IS: 1255 and other Indian Standard Codes of practices.

16.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.

16.21 Contractor shall remove the RCC/Steel trench covers before taking up the work and shall replace all the trench covers after the erection-work in that particular area is completed or when further work is not likely to be taken up for some time.

16.22 Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

16.23 Contractor shall paint the tray identification number on each run of traysat an interval of 10 m.

16.24 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Owner. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the CSPTCL, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

16.25 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

16.26 **Cable trays**

i) The cable trays shall be of perforated GI sheet and minimum thickness of sheet shallbe 2mm.

ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to

demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

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

b) Deflection Test : (Type Test)
A 2.5 metre straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shallbe applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

16.27 **Conduits, Pipes and Duct Installation**

16.27.1 Contractor shall supply and install all rigid conduits, mild steel pipes,flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

16.27.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

16.27.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.

16.27.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.

16.27.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull wire of adequate size shall be laid in all conduits before installation.

16.27.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

16.27.7 Embedded conduits shall have a minimum concrete cover of 50 mm.

16.27.8 Conduit run sleeves shall be provided with the bushings at each end.

16.27.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so asnot to damage the cables.

16.27.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.

16.27.11 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

16.27. 12 For underground runs, Contractor shall excavate and back fill as necessary.

16.27. 13 Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes, ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed male plugs, nipples, gland sealing fittings ,pull boxes, conduits terminal boxes, gaskets and box covers, saddle terminal boxes, and all

steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.

16.27. 14 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

16.27.15 Size of conduit for lighting shall be selected by the Contractor duringdetailed engineering.

16.27.16 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

16.27.17 Conduit supports shall be provided at an interval of 750mm for horizontalruns and 1000mm for vertical runs.

16.27.18 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylonrawl plugs. Wooden plug inserted inthe masonary or concrete for conduit support is not acceptable.

16.27.19 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

16.27.20 Spacing of embedded conduits shall be such as to permit flow of concretebetween them.

16.27.21 Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.

16.27.22 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

16.27.23 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

16.27.24 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.

16.27.26 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

16.27.27 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

16.27.28 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead issuitable for application on embedded conduit and red lead for exposed conduit.

16.27.29 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

16.27.30 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

16.27.31 After installation, the conduits shall be thoroughly cleaned by compressedair before pulling in the wire.

16.27.32 Lighting fixtures shall not be suspended directly from the junction box inthe main conduit run.

17.0 JUNCTION BOX

a) The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for

erection are also included in the scope of the Contractor.

b) Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are level, plumb and properly aligned to present a pleasing appearance.

c) Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The Contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

18.0 TESTING AND COMMISSIONING

18.1 An indicative list of tests for testing and commissioning is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./instructions of the equipment Contractor or Owner without any extra cost to the Owner. The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates and shall furnish the list of instruments to the Owner for approval.

18.2 GENERAL CHECKS

(a) Check for physical damage.
(b) Visual examination of zinc coating/plating.
(c) Check from name plate that all items are as per order/specification.
(d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
(e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.
(f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.
(g) Check cleanliness of insulator and bushings.
(h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.
(i) Check for surface finish of grading rings (Corona control ring).
(j) Pressure test on all pneumatic lines at 18.5 times the rated pressure shall be conducted.

18.3 STATION EARTHING

a) Check soil resistivity
b) Check continuity of grid wires
c) Check earth resistance of the entire grid as well as various sections of the same.
d) Check for weld joint and application of zinc rich paint on galvanised surfaces.
e) Dip test on earth conductor prior to use.

18.4 'MOOSE' ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS

a) Physical check for finish
b) Electrical clearance check

c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.
d) Contact Resistance test on all power connectors.
e) Sag and tension check on conductors.

18.5 **ALUMINIUM TUBE WELDING**

a) Physical check
b) Contact Resistance test on all joints.
c) Dye penetration test & Radiography test on 10% sample basis on weld joints.
d) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

18.6 INSULATOR

Visual examination for finish, damage, creepage distance etc.

18.7 All pre/commissioning activities and works work for substation equipment shall be carried out in accordance with owner's "Pre- Commissioning procedures and formats for substation bay equipments" by the contractor. This document shall be provided to the successful contractor during detailed engineering stage.

19. Testing Procedure for ACSR 'MOOSE' Conductor

1.0 **UTS Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 80 kN and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to 161.2 kN and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

2.0 **Corona Extinction Voltage Test**

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per Annexure-C, Corona extinction voltage shall not be less than 320 KV (RMS) Line to ground.

3.0 **Radio Interference Voltage Test**

The sample assembly similar to that specified under (2.0) above shall be tested as per Annexure - C . Maximum RIV level (across 300 ohm resistor at 1 MHz) at 305 KV (RMS) line to ground voltage shall be 1000 micro volts.

4.0 **D.C Resistance Test on Stranded Conductor**

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a suitable Digital microohmmeter. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per clause no. 12.8 of IS:398 (Part V)-1982. The resistance corrected at 20°C shall conform to the requirements of this specification.

5.0 **Chemical Analysis of Zinc**

Samples taken from the zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

6.0 **Chemical Analysis of Aluminium and Steel**

Samples taken from the Aluminium ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

7.0 **Visual Check for Joints, Scratches etc.**

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conform to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

8.0 **Dimensional Check for Steel and Aluminium Strands.**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

9.0 **Check for Lay-ratios of various Layers.**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification and clause no. 9.4 and 9.5 of IS-398 (Part - V) 1982.

10.0 **Galvanising Test**

The test procedure shall be as specified in IS:4826-1968. The material shall conform to the requirements of this specification.

11.0 **Torsion and Elongation Tests on Steel Strands**

The test procedures shall be as per relevant clause of IS:398 (Part V), 1982. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand before stranding & 16 after stranding. In case test sample length of less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

12.0 **Breaking load test on welded Aluminium strand:**

Two Aluminium wires, shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the bidder

20. Testing procedure for Galvanised Steel Earthwire

1. **UTS TEST**

   Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at steady rate upto 34 KN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 KN and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.

2. **D.C. RESISTANCE TEST**

   On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. the test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. **Visual check for joints, scratches etc. and length of earthwire**

   Earthwire drums shall be rewound in the presence of the inspector. The inspector shall visually check for joints, scratches etc. and see that the earthwire

generally conforms to the requirements of this specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

4. **TORSION AND ELONGATION TESTS**
The test procedure shall be as per relevant clause of IS:398 (Part-V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. Inelongation test, the elongation of the strand shall not be less than 64% or a gauge length of 200 mm.

5. **DIMENSIONAL CHECK**
The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. **LAY LENGTH CHECK**
The lay length shall be checked to ensure that they conform to the requirements of this specification.

7. **GALVANISING TEST**
The test procedure shall as specified in IS:4826-1968. The material shall conform to the requirements of this specification.

8. **CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING**
Samples taken from zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

9. **CHEMICAL ANALYSIS OF STEEL**
Samples taken from steel ingots/coils/strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

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 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).

2. **Test Levels:**
The test voltage levels for measurement of external RIV and for coronaextinction 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%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 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 noisel 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 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130%, 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 darkeness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall lbe 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.

In case corona inception does not take place at 130%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

4.1 The test shall be recorded on each photograph. Additonal 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 inspector if, in his opinion, it will not prejudice other test.

TECHNICAL PARTICULAR :

A. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 400kV GANTRY STRUCTURE

Sl.No	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	Short circuit force per Phase	Spacer Span
1	54 Mtr	QUAD	6 mtr	4 T	5.1 T	5 mtr
2.	70 Mtr	TWIN	6 mtr	4 T	5.1 T	5 mtr

B. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220 kV GANTRY STRUCTURE

Sl.No	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	Short circuit force per Phase	Spacer Span
1	54 Mtr	QUAD	4.0 mtr	4 T	5.7 T	2.5 mtr
2	54 Mtr	TWIN	4.0 mtr	2 T	3.5 T	2.5 mtr
3	74 Mtr	TWIN	4.0 mtr	4 T	5.7 T	2.5 mtr

C. MINIMUM CLEARANCES:

Sl. No.	Particular	400kV	220kV
1	Between Phases to phase	4000mm	2400mm
2	Between phase to Earth	3500mm	2100mm
3	Sectional clearance	6500mm	5000mm
4	Ground clearance	8000mm	5550mm

D. PARAMETERS FOR WHICH THE SYSTEM IS DESIGNED FOR

1	System voltage	420kV rms	245kV rms
2	Lightning Impulse withstand voltage	1450kVp	1050kVp
3	Switching Impulse withstand voltage	1050kVp	------
4	Power frequency withstand voltage	630kV rms	460kV rms
5	Nominal creapage distance	10500mm	6125mm
6	Maximum Fault Level	50kA/1 sec	50kA/1 sec

E. CONNECTION TYPES:

A	**400kV SWITCH YARD**	**Level from plinth**	**Conductor type**
1	Main Bus I & II	+15000 mm	Quad ACSR Moose
2	Jack Bus	+22000 mm	Twin ACSR Moose
3	Equipment to Equipment	+8000 mm	AL . Tube
4	CVT- LA in Line Bay	+8000 mm	Twin ACSR Moose
5	ISOL- BPI-LA-TRAFO	+8000 mm	Twin ACSR Moose
6	Droppers	---	Twin ACSR Moose
7	Earth wire	+29500 mm	10.98 mm GS wire
B	**220kV SWITCH YARD**		
1	Main Bus I & II	+11700 mm	Quad ACSR Moose
2	Jack Bus	+16200 mm	Twin ACSR Moose
3	Equipment to Equipment	+5900 mm	AL . Tube
4	CVT- LA in Line Bay	+5900 mm	Twin ACSR Moose
5	ISOL- BPI-LA-TRAFO	-----	--------
6	Droppers	-----	Twin ACSR Moose
7	Earth wire	+21200 mm	10.98 mm GS wire
8	Bus transfer bay	----	Twin ACSR Moose
9	Bus coupler bay	----	Quad ACSR Moose
10	Auxiliary Bus	+11700 mm	Twin ACSR Moose

RELAY AND PROTECTION PANELS

(Applicable for Sub-station with Automation System)

1.0 SCOPE :

This section contains the technical specifications for the indoor control, indication, relay and metering panels associated with the outdoor switchgear for the sub-station under the 400KV, 220 KV and 33 KV transmission scheme of purchaser. The various control and relay panels shall be complete in themselves with all main and auxiliary relays, fuses, link switches wherever necessary, small wiring, labels, terminal boards, earthing terminals, foundation bolts etc.

1.1 CONSTRUCTIONAL FEATURES

1.12 Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from either front or rear for relay panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

1.2 Relay panels shall be of simplex type design as indicated.It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes is properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

1.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than **IP-31** in accordance with IS:2 147.

1 .4 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

1.5 All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh

1 .6 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials which shall be supplied by the contractor, shall be placed between panel & base frame.

1.7 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

1.8 Relay panels of modern modular construction would also be acceptable.

2. MOUNTING

2.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

2.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

2.3. The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

2.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

2.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

2.6. No equipment shall be mounted on the doors.

3. **PANEL INTERNAL WIRING**

3.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally

3.2. All wiring shall be carried out with 1100V grade, single core,numbered at convenient distances, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
- All current transformer circuits one 2.5 sq.mm lead.
- Voltage transformer circuit (for energy meters): One 2.5 mm sq.per lead
- CT/PT wires shall have red,yellow,blue colours for phases and black for neutral.
- Control wires(DC) wires shall be grey AC wires shall be black.

3.3 All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

3.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

3.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

3.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

3.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments

4. TERMINAL BLOCKS

4.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

4.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

4.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

4.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 6 mm Sq. copper.
- AC/DC Power Supply Circuits : One of 6mm Sq. Aluminium.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

4.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

4.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The

side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

4.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

5. PAINTING

5.1. All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practice for phosphating iron and steel".

5.2. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

5.3. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

5.4. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

5.5. The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

5.6. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

5.7. A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

6. NAME PLATES AND MARKINGS

6.1. All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.

6.2. All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

6.3. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

6.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.

6.5. All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date , Name of the Substation & feeder and reference drawing number.

7. MISCELLANEOUS ACCESSORIES

7.1. **Plug Point:** 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

7.2. **Interior Lighting:** Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

7.3. **Switches and Fuses:** Each panel shall be provided with necessary arrangements for receiving, distributing and isolating 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 breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS: 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. . Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

8. EARTHING

8.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

8.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

8.3. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

8.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.

8.5. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

8.6. An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

9. RELAYS

9.1. All protective relays shall conform to the requirements of IEC61850 and other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

9.2. **All main protective relays shall be of numerical type and communication protocol IEC 61850 compliant. All main relays shall have minimum two Ethernet/RJ45 ports. Further , the test levels of EMI as indicated in IEC 61850 shall be applicable to these .The exact model of the relays shall be finalised by CSPTCL at the time of engineering and that shall be binding on the contractor. Bay controller Unit being the heart of the Substation Automation System, shall be a separate state of art Numerical relay dedicated for the purpose having at least 20 % spare input and 20 % spare output contacts over and above the used contacts. The BCU shall also have two Ethernet/RJ ports for achieving redundancy** in **Ethernet switch connection.Any other numerical relay of the bay shall be configured to perform as a back up BCU for critical monitoring and control functions in the event of outage of main BCU.**

9.3. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply. All protective relays shall have sufficient nos of spare output and input contacts.

9.4. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the 220 DC voltage as specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

9.5. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

9.6. All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this

purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

9.7. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

9.8. No control relay which shall trip the power circuit breaker when the relay is de energised shall be employed in the circuits.

9.9. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

9.10. Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

(a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

(c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

(d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s),but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

(e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

(f) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.

(g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

9.11. All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.

9.12. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

9.13. Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the CSPTCL.

9.14. The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

9.15. All relays and their drawings shall have phase indications as R-red, Y-yellow, B-blue

9.16. For numerical relays, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation.

b) The relay shall have suitable communication facility for connectivity to SCADA.

The relays shall be capable of supporting IEC 61850 protocol.

10. TRANSMISSION LINE PROTECTION

10.1. All relays shall be suitable for series compensated line.

10.2. The line protection relays are required to protect the line and clear the faults on line within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. The general concept is to have two main protections having equal performance requirement specially in respect of time as called Main-I and Main-II for 400KV and 220KV transmission lines. These Distance protection relays should have sub cycle operating time.

10.4. The maximum fault current could be as high as 50 kA but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.

10.5. The protective relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.

10.6. Fault Recorder, Distance to fault Locator and Over voltage relay (stage -1) functions if offered as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements.

10.7. Inbuilt Auto reclose relay function if offered as an integral part of Numerical LBB relay, shall be acceptable for 220kV lines only provided the auto reclose relay feature meets the technical requirements as specified in the respective clause.

10.8. The following protections shall be provided for each of the Transmission lines:

For 400 KV & 220KV

Main-I: Numerical distance protection scheme (with back up IDMT directional earth faultprotection) having sub cycle operating time capability.

Main-II: Numerical distance protection scheme (with back up IDMT directional earth fault protection) having sub cycle operating time capability (of a make or type different from that of Main –I)

10.10. The detailed description of the above line protections is given here under. 10.10.1. **Main-I and Main-II Numerical Distance Protection schemes**:

The relay shall be suitable to the following:-

i. **DC auxiliary supply**: - 220 V (Minimum range +/- 30 %)
ii. **Line length**: - 0.5 km to 400 km, single/double circuits
iii. **System earthing**: - solidly grounded
iv. **Max. Ambient temperature**: 55 degrees centigrade
v. **AC Voltage inputs (Secondary**): Nominal 110 Volts
vi. **AC Current Inputs (Secondary)**: 1 Amp. Nominal, 3 Amps. Continuous
vii. **Nominal System frequency**: 50 Hz.
viii. The relay shall have independently adjustable reactive or impedance and resistive reaches for all zone characteristic for maximum selectivity and maximum fault resistance coverage. It shall have adjustable characteristic line angle.
ix. The relay shall have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) with CVT being used on the line for all types of faults anywhere in the protected line section during both max and min generation conditions.
   a) For SIR 0.01-4, as 40 ms at the nearest end and 60 ms at the other end of the line with carrier transmission time taken as 20 ms.
   b) For SIR 4-15 as 45 ms at the nearest end and 65 ms at the other end of line with carrier transportation time taken as 20 ms.
x. **Output Contacts**: At least 24 Standard outputs. **Opto isolated inputs**: At least 24 inputs with no shared terminals. DC voltage – 110/220 (compatible with supply voltage) Volts DC

xi. **Phase Distance Protection.** The relay shall incorporate at least four zones of mho/quadrilateral distance protection for detection of phase faults. At least one zone shall be settable for either forward or reverse direction. Positive-sequence memory polarization shall be used to provide stable reach and reliable operation for zero voltage faults.

xii. **Ground Distance Protection.** The relay shall incorporate at least four zones of mho/ quadrilateral distance protection for detection of faults involving ground. At least one zone shall be settable for either forward or reverse direction. Ground elements shall not overreach on multiphase faults and shall not be affected by load flow.

xv. **The relay shall be suitable for single and three pole tripping.**

xvi**.** **Relay setting Groups:** The relay shall have at least four setting groups.

xvii. Include fuse failure protection/ Loss of voltage feature which shall:

a) Monitor all three phase fuses of capacitance / electro-magnetic voltage transformer and associated cables against open circuit.
b) Inhibit tripping on sudden total loss of voltage or one/two fuse fail condition and initiate annunciation.
c) Have an operating time less than 7 ms.
d) Remain operative for system earth fault.

xviii. **Over current/Earth Fault Protection**. The relay shall have built in an independent directional/non- directional (selectable) Earth fault protection element to detect highly resistive faults. These elements shall have IDMT characteristic with a definite minimum time of 3.0 sec. at 10 times setting and shall have variable setting range of 20-80% of rated current and characteristics angle 45 degree lag.

Further it shall have directional/ non-directional (selectable) back up over current function in built. This element shall have IDMT characteristic with a definite minimum time of 3-0 seconds at 10 times setting having a variable setting.

xix. **Breaker Failure Logic**. The relay shall incorporate breaker failure logic for single- and three-pole tripping and reclosing Re-trip and transfer trip initiate contacts shall be provided. Pole discordance logic shall be included.

xx. **SOTF**: The relay shall have switch on to fault protection function.

xxi. **Auto-Reclosing with synchro-check facility.** The relay shall incorporate both single- and three- pole reclosing with four separately set open time intervals for three-pole and two intervals for single-pole reclosing.It shall

a) Have single phase and three phase re-closing facilities
b) Have a continuously variable single phase dead time of 0.5 to 5 seconds
c) Have continuously variable three phase dead time range of 0.5 to 5 seconds.
d) Have a continuously variable reclaim time range of 5-25 seconds
e) Incorporate a four-position selector switch from which single phase/three phase/single and three phase/auto re-closure and non-auto re-closure mode can be selected
f) Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.
g) Be of single/multishot type
h) Include check synchronizing relay which shall
   i Have a time setting variable between 0.5 to 5 seconds.
   ii Have a response time within 200 ms with the timer disconnected.
i) Include dead line charging relay.
j) Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

k) Incorporate a separate pole discrepancy relay with timing range of 0.1 to 1 sec
l) Auto re-closure of the line shall take place only when fault is cleared in first zone by the main protection.
m) Incorporate auto re-closure lockout features to prohibit auto re-closure under the following conditions.
   i Tripping due to operation of bus bar protection.
   ii Tripping immediately after the manual closer of line breaker.
   iii Tripping for faults in 2nd and 3rd zone as backup.
   iv When tripping takes place after a power swing condition.
   v In the event of trip on pole discrepancy.
   vi When carrier is out of service.
n) It should have positive phase selections under all operating conditions. The scheme should be such that shut down and testing on one Main protection should not affect the other Main protection. The auto re-closure should then be connected to the other Main protection.
o) Come in to operation with distance protection when these protections operate for Zone-I fault and trip the breaker.

Auto re-closure settings

a) Operating Mode Only 1-Pole,
   Only 3-Pole,
   1 or 3-Pole
b) Dead Time 0.5 to 5 sec
c) Reclaim Time 5 to 25 sec

xxii. **Event Reporting and Sequential Events Recorder**. The relay shall store event data recorded in nonvolatile memory. The relay shall include an SER (Sequential Events Recorder) report that stores the latest 500 entries of at least 50 monitored points.

xxiii. **Operator controls.** The relay shall include operator control pushbuttons on the relay front panel. Each pushbutton shall be programmable and accessible in the relay control logic. Facilities shall be available through a soft touch keypad on the HMI for setting alteration, display of all settings, scheme logics and any other requirements as per the software and hardware configuration of the system other than the menu driven alarms.

xxiv. **LED indications:** The relay shall have minimum 12 Nos. freely configurable LED indications for immediate visual information of relay operation.

xxv. **Fuse failure protection/ Loss of voltage feature.** It shall **:**

a) Monitor all three phase fuses of capacitance / electro-magnetic voltage transformer and associated cables against open circuit.
b) Inhibit tripping on sudden total loss of voltage or one/two fuse fail condition and initiate annunciation.

xxvi. **Pass word Protection.** The relay shall have multilevel pass wards to safeguard protection and automation settings.

xxvii. **Fault Locator**. The relay shall include a fault-locating algorithm to provide an accurate estimate of fault location without communications channels or special instrument transformers. It shall have an accuracy of 5% or better for all types of faults and fault levels.

a) It shall provide digital indication of distance to fault in percentage of the supervised line length of kilometers or in kilometers directly without requiring further calculations.
b) It shall provide distance to the fault together with information about the measuring loop that has been used in the calculations.
c) Information of the last 08 disturbances should be available.

d) The fault locator algorithm compensates the effect of the load currents, the apparent fault resistance and zero sequence mutual impedance.

e) It shall meet IEC-255 or other equivalent recognized standards.

f) It shall be suitable for breaker operation time of 2 cycles.

g) The above accuracy shall not be impaired under the following conditions.

i Presence of remote end in feed.

ii Predominant DC components in fault current.

iii High fault Arc resistance.

iv Severe CVT transients.

xxviii. **Digital Relay-to-Relay Communications.** The relay shall have send and receive logic elements, and analog and virtual terminal elements in each of two communications ports for dedicated relay-to-relay communications. Channel aided schemes should be implementable.

xxix. **Relay Logic.** The relay shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes. Logic shall have the ability to use relay elements, math functions, comparison functions, and Boolean logic functions.

xxx. **IEC 61850 Ethernet Communications.** The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data point.

Relay shall have two independent Ethernet communication ports (internal switch in the relay shall not be acceptable) on the rear supporting both fiber as well as RJ 45 communication options to provide (1) all the facilities available via the integral user interface and (2) facilities supplier under IEC 61850 interface.

xxxi. Communication. The relay shall include independent EIA-232 serial port for external communication.

xxxii. **PC Interface.** The relay shall be capable of being set by Windows-base graphical and ASCII terminal interface.

xxxiii. **IRIG-B Time Input.** The relay shall include an interface port for either a standard or high-accuracy demodulated IRIG-B time synchronization input signal.

xxxiv. **HMI Display.** The relay shall include custom configurable display information to display status on HMI, analog quantities, text and alarm information.

xxxv**. Environment.** The relay shall be suitable for continuous operation over a temperature range of -5 degree to + 55 degree Celsius.

xxxvi. **Self-monitoring**: Upon detecting a failure, the relay shall be able to provide useful diagnostic information to speed up maintenance. The relay shall be provided with a continuous self-monitoring and diagnostic unit to give alarm in case of abnormalities and locate defective units immediately. Self-monitoring should cover microprocessor, EPROM contacts, measuring elements, battery status and all associated program.

xxxvii. **Metering Functionality:** Shall include metering capabilities for real time current, Voltage, power, energy qualities, as well as phase demand and peak demand current values. Necessary software for relay settings, configuration of digital inputs, outputs, logic, viewing of fault records disturbance records etc. should be supplied as part of relay.

xxxviii. The maximum fault current could be as high as 40KA & minimum fault current could be as low as 20% of rated CT secondary current

xxxix. I/P, O/P and LED should be freely configurable.

xxxx. Numerical full scheme distance protection terminal shall be suitable for use with any communication scheme (permissive under reach, over reach, blocking) and have facility for connection to sub – station automation system.

xxxxi. Have **Disturbance recording** facility, which records a minimum of 08 analogue channels (phase and residual values) and a minimum of 32 digital programmable digital channels, which shall include various digital inputs, output relays and internal digital signals. The facility must be capable of recording at least 10 disturbances. The duration of record shall be settable and be adequate to capture maximum possible information and be bifurcated in pre-fault & post-fault time. Necessary software shall be provided for retrieving and analyzing the records.

xxxxii. **Out-of-Step Characteristics**. The relay shall detect stable and unstable power swings. User settings shall determine whether the relay trips or blocks tripping It shall:

a) Have separate measuring element for power swing detection.
b) Have fast detection of power swing.
c) Shall be on the principle of measurement of the rate of impedance vector change and monitoring of the vector path.
d) Have selective blocking of zones.
e) Have settable unblocking criteria for earth faults, phase faults and three phase faults.
f) Have the Earth fault detection feature, which shall over ride power swing blocking and allow the relay to operate for trip as per zone detection.
g) The relay shall be blocked for the set time for the first PS sensed and remain unblocked for the set time for the successive PS.

xxxxiii. The relay shall have provision of Broken Conductor Detection / protection with alarm/trip facility to detect open conductor condition by way of level detector or negative sequence measurement.

xxxxiv. Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.

The Following shall also be ensured :

(a) The exact model of the offered relay shall be finalised by CSPTCL at the time of the engineering and it shall be binding on the contractor.
(b) shall be non-switched type with separate measurements for all phase to phase and phase to ground faults
(c) shall have the provision of receiving the main and tie CT inputs separately.
(d) shall have stepped time-distance characteristics and minimum four independent zones(zone 1, zone-2 , zone-3,zone 4)
(e) shall have mho or quadrilateral or other suitably shaped characteristics for zone-1 , zone-2 and zone- 3.
(e) **shall have subcycle (less than 20 ms) operating time,**
(f) shall have independent continuously variable time setting range
(g) shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)
(i) shall have variable residual compensation.
(j) shall have weak end in-feed feature
(k) shall be suitable for single & three phase tripping.
(l) **Shall have sufficient nos of freely configurable output and input contacts.(shall have min 20% extra output and input contacts over and above what is required in the scheme for future use)**
(m) shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 50 times rated current without damage for a period of 1 sec.
(n) shall be provided with necessary self reset type trip duty contacts for completion of the scheme (Minimum number of these trip duty contacts shall

be six per phase) either through built in or through separate high speed trip relays . Making capacity of these trip contacts shall be 30 amp for 0.2 seconds with an inductive load of L/R > 10 mill seconds. If separate high speed trip relays are used , the operating time of the same shall not be more than 10 milliseconds

(o) shall be suitable for use in permissive under reach / over reach /blocking
communication mode.

(p) shall have suitable number of potential free contacts for Carrier aided Tripping,
Auto reclosing, CB failure, Disturbance recorder & Data acquisition system.

(q) include power swing blocking protection which shall
- have suitable setting range to encircle the distance protection described above.
- block tripping during power swing conditions.
- release blocking in the event of actual fault

(s) include fuse failure protection which shall monitor all the three fuses of C.V.T. and associated cable against open circuit.
- inhibit trip circuits on operation and initiate annunciation.
- have an operating time less than 7 milliseconds
- remain inoperative for system earth faults

(t) include a directional back up Inverse Definite Minimum Time (IDMT)directional earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature

(u) In case the numerical distance relay is not having the built in feature as per above clause (t), the same can be supplied as an independent relay

(v) **The relays shall have terminal blocks suitable for wiring ring(eye) type lugs for CT and PT wires.**

10.10.2. **Back-up Directional Over Current and Earth fault protection scheme.**
Shall be a separate relay other than Main I and II relays.

Numerical Directional Numerical Over current and Earth fault Relay shall be IEC 61850 compliant. It shall have;

i. 3 over current and 1 Earth Fault elements.
ii. selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.
iii. High set over current with selectable time delay.
iv. High set Earth fault with selectable time delay
v. adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively Suitable to decide directionality through zero sequence quantity and through external open delta voltage input
vi. in built Breaker Failure Protection.
vii. Include hand reset Flag/LED indicators for fault.
viii. Readable Human Machine Interface with LCD display. viz. Fault current, Faulty Phase etc with time stamp.
ix. Shall have Disturbance Recording facility for minimum 3 sec for each fault.
x. Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.
xi. Disturbance Recording facility for minimum 3 sec for each fault.
xii. Shall be Self monitoring type.
xiii. Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.

xiv. The relay shall include an interface port for IRIG-B time synchronization input signal.

xv. The relay shall have Auto reclose and Check-synchronising feature also.

Technical Parameters:

a.	Current Rating	1A, 50 Hz ±2.5 Hz
b.	Voltage Rating	110 V, 50 Hz ±2.5 Hz
c.	Auxiliary Supply	220 V DC ±25 %
	Relay settings:	
a.	Over Current	50% - 200% (In steps of 5%)
b.	Earth Fault	5% - 80% (In steps of 5%)
c.	High set O/C	0.5 – 15 times In or more
d.	High set E/F	0.5 – 12 times In or more
e.	Time multiplier for IDMT	0.05 – 1.0 (In steps of 0.025) (Independent for O/C & E/F)
f.	Time delay for high set element	0.02 to 2 sec (in steps of 0.01 sec)
g.	Pick up	Within 1.1 times of set current value
h.	Reset current	95% to 90% of pick-up current
i.	Operating Time	As per selectable characteristic. For Inst. Element < 40 ms for 2xIn
	Other Features	
a.	Binary inputs	Min. 12 No. freely configurable and suitable 110 VDC
b.	Outputs	Minimum 12 freely configurable contacts
c.	Continuous carry	5 A
d.	Make & Carry for 0.5 s	30 A
e.	Make & Carry for 3.0 s	15 A
f.	Station Aux. DC	110 V/220 V DC
g.	Communication	• RS232/RS485, Fiber optic ports
		• IEC 61850 protocol
		• Time Synchronization: IRIG B port
h.	Housing	• Flush Mounting
		• Screw Terminals (‘O’ Lug for CT Connection)

10.10.3. **All trip relays used in transmission line protection scheme shall be of self/electricalreset type depending on application requirement.**

11. **Numerical Circuit Breaker Auto Reclosure Relay :** shall be IEC61850 compliant.

This shall include following functions:

11.1. AUTO RECLOSING function shall be incorporated in a Numerical relay separate from Main-I and Main-II protection and shall have single phase or/and three phase reclosing facilities

(a) shall be IEC61850 compliant and shall have at least two nos Ethernet/RJ45ports.
(b) The exact model of the relay shall be finalised by CSPTCL at the time of the engineering and it shall be binding on the contractor.
(c) have a continuously variable single phase dead time range of 0.1-2 seconds.
(d) have a continuously variable three phase dead time range of 0.1-2 seconds.
(e) have a continuously variable reclaim time range of 5-300 seconds.
(f) incorporate a four-position selector switch/ from which single phase/three

phase/single and three phase auto reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

(g) have facilities for selecting check synchronising or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.

(h) be of single shot type.

(i) have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers

(j) shall have check synchronising feature which shall

- have a time setting continuously variable between 0.5-5 seconds. with a facility of additional 10 seconds.
- have a response time within 200 milli seconds with the timer disconnected.
- have a phase angle setting not exceeding 35 degree
- have a voltage difference setting not exceeding 10%
- include dead line charging relay which shall
- shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
- incorporate necessary auxiliary relays and timers to give comprehensive scheme.

11.2. **LOCAL BREAKER BACK-UP PROTECTION SCHEME** shall be of Numerical type and separate from Main 1 and Main 2 relays.It shall be IEC61850compliant and shall have two nos ethernet ports.

(a) Shall be phase segratgated type.

(b) have an operating time of less than 15 milli seconds

(c) have a resetting time of less than 15 milli seconds

(d) have three over current elements

(e) be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer /reactor equipment protections

(f) have a setting range of 20-120 % of rated current

(g) have a continuous thermal withstand two times rated current irrespective of the setting

(h) have a timer with continuously adjustable setting range of 0.1-1 seconds

(i) have necessary auxiliary relays to make a comprehensive scheme.

(j) The exact model of the LBB relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.

(k) In case the breaker fails to trip within 200 ms of the trip relay operation; the LBB relay shall be allowed to trip all the breakers connected to the BUS. An independent numerical LBB relay, IEC: 61850 compliant should be provided. The LBB relay shall have IRIG B port time synchronization. This relay shall have the provision for independent setting of current and independent time delay. The relay contacts shall be terminated up to terminal block. LBB trip circuits ferrule numbers shall be 'P' series.

(l) Local breaker backup protection scheme shall:

a) Comprise of a breaker failure initiating relay, breaker failure relay which supervises the fault current flowing through the breaker being protected against failure and breaker failure time delay relay and breaker failure lockout relay.

b) The operation of both breaker failure initiating relay and breaker failure relay will initiate timer relay which in turn operate lockout relay. The lockout relay will have N/O contacts for annunciation and for energisation of bus bar protection trip relays (available separately as per the scheme) for tripping all the other breakers connected to the bus.

(m) Breaker failure relay scheme above shall:
(n) Be suitable for 220 V DC supply.
(o) have a resetting time of less than 15 ms.
(p) Have necessary auxiliary relays to make a comprehensive scheme. The scheme shall be so engineered that in the event of persisting breaker lockout condition and simultaneous incidence of fault shall result in instantaneous tripping of the concurred bus bar to which the faulty breaker is connected.

11.3. **TRIP CIRCUIT SUPERVISION RELAY**

(a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
(b) The relay shall have adequate contacts for providing connection to alarm and event logger.
(c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

12. **LINE OVER VOLTAGE PROTECTION RELAY** shall be of Numerical type and IEC61850 compliant.

(a) monitor all three phases
(b) have two independent stages and stage- 1 & II relay are acceptable as built in with line distance relays Main I & II respectively .
(c) have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60 seconds for the first stage.
(d) have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200 mill seconds for the second stage.
(e) be tuned to power frequency
(f) provided with separate operation indicators (flag target) for each stage relays.
(g) have a drop-off to pick-up ratio greater than 95%.
(h) provide separate out-put contacts for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirements.

13. REACTOR PROTECTION

13.1. Numerical Differential Protection shall same specification as that for the Transformer as given in clause 14.1.

(a) IEC61850 compliant
(b) The exact model of the relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.
(c) Shall have two Ethernet ports
(d) be triple pole type
(e) have operation time less than 20 milli-seconds(sub cycle) at 5 times setting.
(f) be tuned to system frequency
(g) have current setting range of 10 to 40% of 1 Amp. Or a suitable voltage setting range.
(h) be high impedance biased differential type .
(i) be stable for all external faults

13.2. Numerical Restricted earth fault protection Relay shall be IEC61850 compliant & separate from Differential Relay and shall

(a) be single pole type

(b) be of current/voltage operated high impedance type
(c) have a current setting of 10-40% of 1 Amp.
(d) be tuned to system frequency.
(e) have a suitable non-linear resistor to limit the peak voltage to 1000 Volts.
(f) Shall have two Ethernet ports

13.3. Numerical Back up impedance protection Relay shall

(a) shall be IEC61850 compliant and shall have two Ethernet ports.The exact model of the relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.
(b) be triple pole type, with faulty phase identification indication
(c) shall have multiple characteristic including single step polarised 'mho' distance impedance relay suitable for measuringphase to ground and phase to phase faults.
(d) have adequate ohmic setting range to cover at least 60 % of the impedance of the reactor and shall be continuously variable.
(e) have an adjustable characteristic angle of 30-80 degree.
(f) have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds.
(g) include VT failure relay which shall block the tripping during VT fuse failure.

13. TRANSFORMER PROTECTION

14.1. The following protections shall be provided for each of the 315 MVA Transformers :

Main-I: **Numerical Differential protection scheme having sub cycle operating time capability.**

Main-II: **Numerical Differential protection scheme having sub cycle operating time capability (of a make or type different from that of Main –I)**

Numerical Transformer differential protection scheme(three winding)one each on separate panels ,shall have sufficient nos of freely configurable output and input contacts.(shall have min 20% extra output and input contacts over and above what is required in the scheme for future use)

(a) **shall be IEC61850 compliant and shall have two nos RJ45 ports or other Ethernet ports.**
(b) The exact model of the relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.
(c) be triple pole type, with faulty phase identification/ indication
(d) **have an operating time not greater than 20 milli seconds(subcycle) at 5 times the ratedcurrent** .
(c) have three instantaneous high set over-current units
(d) have an adjustable bias setting
(e) be suitable for rated current of 1 Amp.
(f) have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetising inrush proof feature shall not be achieved through any intentional time delay e.g use of timers to block relay operation or using disc operated relays
(g) have an operating current setting of 15% or less
(g) have internal feature in the relay to take care of the angle & ratio correction
(h) have 3 phase Bus PT voltage inputs also

(i) have a disturbance recording feature to record graphic form of instantaneous values of current in all three windings in nine analogue channels, during faults and disturbances for the pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

1. REF protection operated
2. HV breaker status (Main and tie)
3. LV breaker status
4. Bucholtz /OLTC Bucholz alarm and Trip ;PRD trip
5. WTI/OTI alarm/trip of transformer

Necessary hardware and software for down loading the data captured by disturbance recorder to the personal computer in the substation shall be included in the scope.

14.2. **Over fluxing protection Relays** shall be Numerical type and IEC 61850 compliant.

(a) operate on the principle of Voltage to frequency ratio and shall be phase to phase connected

(b) have inverse time characteristics, matching with transformer over fluxing withstand capability curve.

(c) provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of 'v/f' between 100% to 130% of rated values

(d) tripping time shall be governed by 'v/f' Vs. time characteristics of the relay

(e) have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at 'v/f' values of 1.4 and 1.5 times, the rated values, respectively.

(f) have an accuracy of operating time, better than ±10%.

(g) have a resetting ratio of 95 % or better.

(h) Not acceptable as a built in feature of numerical transformer differential relay

14.3. **Numerical Restricted Earth Fault Protection** shall

(a) be single pole type

(b) be of current /voltage operated high impedance type

(c) have a current setting range of 10-40% of 1 Amp.! have a suitable voltage setting range.

(d) be tuned to the system frequency

14.4. **Back-up Directional Over Current and Earth fault protection scheme.**
Shall be a separate relay other than Main I and II relays.

Numerical Directional Numerical Over current and Earth fault Relay shall be IEC 61850 compliant. It shall have;

i. 3 over current and 1 Earth Fault elements.
ii. selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.
iii. High set over current with selectable time delay.
iv. High set Earth fault with selectable time delay
v. adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively Suitable to decide directionality through zero sequence quantity and through external open delta voltage input
vi. in built Breaker Failure Protection.
vii. Include hand reset Flag/LED indicators for fault.
viii. Readable Human Machine Interface with LCD display. viz. Fault current, Faulty Phase etc with time stamp.
ix. Shall have Disturbance Recording facility for minimum 3 sec for each fault.
x. Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.
xi. Disturbance Recording facility for minimum 3 sec for each fault.

xii. Shall be Self monitoring type.

xiii. Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.

xiv. The relay shall include an interface port for IRIG-B time synchronization input signal.

xv. The relay shall have Auto reclose and Check-synchronising feature also.

Technical Parameters:

a.	Current Rating	1A, 50 Hz ±2.5 Hz
b.	Voltage Rating	110 V, 50 Hz ±2.5 Hz
c.	Auxiliary Supply	220 V DC ±25 %
	Relay settings:	
a.	Over Current	50% - 200% (In steps of 5%)
b.	Earth Fault	5% - 80% (In steps of 5%)
c.	High set O/C	0.5 – 15 times In or more
d.	High set E/F	0.5 – 12 times In or more
e.	Time multiplier for IDMT	0.05 – 1.0 (In steps of 0.025) (Independent for O/C & E/F)
f.	Time delay for high set element	0.02 to 2 sec (in steps of 0.01 sec)
g.	Pick up	Within 1.1 times of set current value
h.	Reset current	95% to 90% of pick-up current
i.	Operating Time	As per selectable characteristic. For Inst. Element < 40 ms for 2xIn
	Other Features	
a.	Binary inputs	Min. 12 No. freely configurable and suitable 110 VDC
b.	Outputs	Minimum 12 freely configurable contacts
c.	Continuous carry	5 A
d.	Make & Carry for 0.5 s	30 A
e.	Make & Carry for 3.0 s	15 A
f.	Station Aux. DC	110 V/220 V DC
g.	Communication	• RS232/RS485, Fiber optic ports
		• IEC 61850 protocol
		• Time Synchronization: IRIG B port
h.	Housing	• Flush Mounting
		• Screw Terminals (‘O’ Lug for CT Connection)

14.5. **Numerical Transformer Overload Protection Relay** shall

(a) Shall be IEC61850 compliant & be of single pole type

(b) be of definite time over-current type

(c) have one set of over-current relay element, with continuously adjustable setting range of 50-200% of rated current

(d) have one adjustable time delay relay for alarm having setting range of 1 to 300.0 seconds, continuously.

(e) have a drop-off/pick-up ratio greater than 95%.

14.6. **NumericalTransformer Neutral Displacement Relay for 400 KV transformer.**

(a) Shall be IEC61850 compliant and have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated voltage.

15. **Technical Specifications of High SpeedTrip Relays**:

High Speed Tripping Relay shall

(a) be instantaneous (operating time not to exceed 10 milli-seconds).
(b) reset within 20 milli seconds
(c) be D.C. operated
(d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
(e) be provided with operation indicators for each element/coil.
(f) As per the system design sufficient relays having potential free contacts for trip circuit 1 & 2 of main breaker and TieCB/TBC. The contacts for trip circuit shall be Heavy Duty.
(g) Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Auto re-close relay, LBB relay, DR/SER Data acquisition and optional trip facility to be connected by Purchaser where needed.
(h) It shall be instantaneous with operating time less than 12 ms. It shall have minimum 18NO & 2NC hand resetting type contacts. It shall be rated for 220VDC operating voltage.
(i) Be provided with operation indicators.
(j) shall be of self-monitoring type

16. **DC SUPPLY SUPERVISION RELAY**

(a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
(b) It shall have adequate potential free contacts to meet the scheme requirement.
(c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

17 **BUS BAR PROTECTION**

17.1 **Features of 400 KV Bus bar differential scheme**:

The numerical, LOW IMPEDENCE, Centralized configuration bus bar protection scheme shall be suitable for 1A, 110V, 50Hz. Two sets of physically independent Bus bar protection schemes i.e. redundant (Main I+ Main II) numerical Bus Bar protection scheme for each bus system of one & half breaker bus scheme i.e (Main I+ Main II) for 400 KV Bus1 + (Main I+ Main II) for 400 KV Bus2 shall be provided. The scheme shall be based on centralized architecture. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same. Each 400 KV bus bar protection scheme shall have provision of voltage inputs of respective Bus CVT.

i. The numerical, low impedance, centralized configuration type with biased differential characteristics, should have operative and restraint characteristics suitable for 220 DC Aux. supply with variation of (-) 20% and (+) 10%. The redundant (Main I+ Main II) numerical Bus Bar protection scheme for each bus system of one & half breaker bus scheme i.e. (Bus1 + Bus 2) shall be on different 220 V DC sources i.e. 220 VDC-1 and 220 VDC-2
ii. The scheme shall be suitable to ensure the isolation of the faulty zone, stable during through fault and shall be backed up by check zone and end zone protection.
iii. The system shall have maximum operating time from trip impulse to trip relay for all types of faults not more than 20 milliseconds at 5 times current setting value.
iv. The scheme shall have operating selectivity for each bus bar and shall also have dynamic zone selection. It shall be possible to isolate any particular bay or zone of the bus bar protection scheme during the maintenance activity without affecting the protection of the complete scheme. The scheme shall be highly stable for external fault.
v. It shall give hundred percent security up to 50 KA fault level.

vi. The scheme shall have continuous supervision for CT secondary against any possible open circuit and CT saturation and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm.

vii. The scheme shall be of phase segregated and triple pole type and shall not give false operation during normal load flow in bus bars and incorporate clear zone indication.

viii. The bus bar protection scheme should have minimum 4 zones of protection.

ix. The scheme shall ensure that all configuration and logics are realized in the relay software. The dynamic replicas shall be provided to show bus bar linking as desired by the system.

x. The bus bar protection scheme should be equipped with IRIG B Port.

xi. The scheme shall annunciate all faults events and monitoring status on a Microprocessor based 24 point annunciation relay to accommodate all annunciations related to the scheme. However, even more number of windows shall be provided to fulfill scheme requirement, if required. The scheme shall have at least two numbers of independent setting groups. The scheme should have at least 8 Nos. LEDs for fault indication.

xii. The scheme should be transient free in operation.

xiii. The scheme should include continuous DC supplies supervision for alarm and trip circuits.

xiv. The scheme should include protection 'IN/ OUT' switch for each zone with alarm and window on annunciation indication.

xv. The scheme shall have disturbance recorder, event logger etc. i.e. complete in all respect.

xvi. The bus bar protection scheme shall have at least two communication ports. It shall have one number independent front Ethernet port/RJ45/RS-232/LAN port for local communication for relay setting, modification, extraction analysis of fault/ event/ disturbance records from laptop and two rear fiber optic ports on IEC-61850 standard for remote communication to SAS. In addition the scheme shall have capability for accurate time synchronization with GPS clock through (IRIG-B port/ PPM/SNTP). The scheme should confirm to at least following requirement of IEC-61850 and necessary certificate shall be furnished for compliance.

(a) Basic Data exchange
(b) Data Sets
(c) Un buffered reporting
(d) Generic object oriented substation events
(e) Time synchronization
(f) File transfer.

xvii. The scheme shall have continuous comprehensive self-diagnostic feature to monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated.

xviii. The scheme shall be a complete package in all respect including all software hardware etc, all auxiliary relays, individual high speed hand reset tripping relays, indication lamps etc, if required.

xix. The scheme shall ensure that no region within the bus bar zone should be left unprotected by the offered bus bar scheme. Fault between isolator and CT in bus coupler section should be detected by the bus bar scheme.

xx. The scheme shall include necessary software for CT ratio correction. No Interposing CT etc. shall be allowed to be used.

xxi. It shall include continuous supervision of each DC supply separately.

xxii. Test terminal block shall be fully enclosed with removable covers and shall be made of moulded, non-inflammable good quality material with boxes barriers molded integrally.

xxiii. The Bus Bar protection scheme shall have 3 phase Bus PT input.

xxiv. Only disconnecting type connector for CTs connections suitable for 10 sq mm copper cable shall be acceptable. For other connections stud type connectors suitable for ring type copper lugs shall be acceptable.

xxv. The scheme should not trip for the differential current below the load current of heaviest loaded feeder.This feature should be provided with enable/disable option.

xxvi. The scheme shall provide on the unit and should be accessible for checking of the menu, setting and DR etc at least in the following way:

(a) HMI on the front of the relay. The bus bar protection scheme shall have a large HMI in the front capable of displaying bay current and all calculated differential current etc.

(b) The relay should display the menu, setting, DR & ER etc. through the keyboard provided on the front of the relay.

(c) The scheme should have RS232/LAN port on the front of the panel for accessing by using personal computer to go through the menu, Setting measurements and disturbance records and dynamic bus bar replica etc. This may be on the propriety protocol. The associated software shall be supplied along with the relay.

(d) It should be provided with suitable port so that all the relays in the system could be brought on the common bus and connected to a common computer available in the S/S for communication for accessibility of menu, disturbance records, event record and bus bar replica etc.

xxv. The numerical relay should have in built breaker failure with 3 phase LBB initiation scheme with the operation and resetting time not more than 20 milli second. The relay shall have adjustable time delay of 100 to 500 ms with tripping time delay of relay not more than 20 milli second.
Auxiliary relays, trip relays, switches etc. if required to facilitate the operation of the scheme shall be fully covered in the scope of supply.

xxvi. The 400 KV Busbar panel shall be suitable for 15 number of bays for each of 400 KV Bus I and 400 KV Bus II in the bus bar protection panel.

220 KV Bus bar /differential scheme: There shall be two sets of 220 KV bus bar protection scheme viz main I & main II .Both main I and main II scheme shall cover the protection of complete 220 KV bus bar (existing 220 KV Bus of 220 KV Dhardehi + proposed 220 KV bus of 400 KV Dhardehi).
At present 220 KV Bus bar protection scheme of M/s GE T& D India Ltd. of relay model B- 90 is in service at 220 KV substation Dhardehi with 10 no of 220 KV bays wired. The bus bar protection panel has provision (spare modules) for proposed 220 KV bays to be integrated. All the spare modules shall be wired up to terminal block for future bus bar protection scheme. It shall be the responsibility of the contractor to provide necessary wiring arrangement and cabling for extension of CT/PT & DC circuit for integration of new 220 KV bays in the existing 220 KV bus bar panel.This will form **220 KV bus bar protection main I** for the integrated substation.

220 KV bus bar protection main II shall be supplied, erected and commissioned by the contractor. Necessary extention of CT/PT and DC circuit belonging to 220 KV bays of existing 220 KV Dhardehi shall be wired to busbar main II in addition to proposed 220 KV bays of 400 KV substation Dhardehi. All the spare modules shall be wired up to terminal block for future bus bar protection scheme. All the necessary accessories and cabling (all

type) are to be provided by the contractor under present scope required for successful completion of the scope of work.

220KV bus bar protection scheme main I and main II each shall cover two main+ one transfer bus(with main & check scheme). The bus bar protection scheme shall have Bus zone 1 differential, Bus zone 2 differential ,transfer bus zone & a common check zone in each units.These two physically independent units shall be named as Main 1 busbar protection & Main 2 bus bar protection.Each 220 KV busbar protection scheme shall have provision of voltage inputs of Bus 1 CVT & Bus II CVT.

The Numerical, LOW IMPEDENCE, Centralized configurations bus bar protection scheme shall be suitable for 1A secondary current, 110V secondary PT voltage, 50 Hz double bus bar with transfer bus of the existing 220KV substations. The 220 KV Bus bar protection scheme shall be suitable for following requirement:

i. The numerical, low impedance, centralized configuration type with based differential characteristics, should have operative and restraint characteristics suitable for 220V DC Aux. supply with variation of (-) 20% (minus 20%) and +10%.
ii. The scheme shall be suitable to ensure the isolation of the faulty zone, stable during through fault and shall be backed up by check zone and end zone protection.
iii. The system shall have maximum operating time from trip impulse to trip relay for all types of faults not more than 20 milliseconds at 5 times current setting value.
iv. The scheme shall have operating selectivity for each bus bar and shall also have dynamic zone selection through isolator replica without the use of external CT switching relays. It shall be possible to isolate any particular bay or zone of the bus bar protection scheme during the maintenance activity without affecting the protection of the complete scheme. The scheme shall be highly stable for external fault.
v. It shall give hundred percent security up to 50KA fault level.
vi. The scheme shall have continuous supervision for CT secondary against any possible open circuit and CT saturation and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm.
vii. The scheme shall be of phase segregated and triple pole type and shall not give false operation during normal load flow in bus bars and incorporate clear zone indication.
viii. The bus bar protection scheme should have minimum 4 zones of protection with zone distribution as mentioned here under:
   Bus-I : zone-I
   Bus-II : zone-II
   Transfer bus : zone-III
   Check zone : zone-IV
ix. The 220 KV Bus bar protection scheme shall include necessary CT switching through relay software or through isolator contract/ replica directly without using external CT switching relays.
x. The 220 KV Bus bar protection scheme shall include individual high speed hand reset tripping relay for each feeder.
xi. The scheme shall ensure that all configuration and logics are realized in the relay software. The dynamic replicas shall be provided to show bus bar linking as desired by the system.
xii. The scheme shall annunciate all faults events and monitoring status on a Microprocessor based 24 point annunciation relay to accommodate all annunciations related to the scheme. However, even more number of windows shall be provided to fulfill scheme requirement, if required. The scheme shall have at least two numbers of independent setting groups. The scheme should have at least 8 Nos. LEDs for fault indication.

xiii. The scheme should be transient free in operation.

xiv. The scheme should include continuous DC supplies supervision for alarm and trip circuits.

xv. The scheme should include protection 'IN/ OUT' switch for each zone with alarm and window on annunciation indication.

xvi. The scheme shall have disturbance recorder, event logger etc. i.e. complete in all respect.

xvii. The bus bar protection scheme shall have at least two communication ports. It shall have one number independent front Ethernet port/RJ45/RS-232/LAN port for local communication for relay setting, modification, extraction analysis of fault/ event/ disturbance records from laptop and two rear fibre optic port on IEC-61850 standard for remote communication to SAS. In addition the scheme shall have capability for accurate time sunchronization with GPS clock through (IRIG-B port/ PPM/SNTP). The scheme should confirm to at least following requirement of IEC-61850 and necessary certificate shall be furnished for the compliance.

(a) Basic Data Exchange
(b) Data Sets
(c) Un buffered reporting
(d) Generic object oriented substation events
(e) Time synchronization
(f) File transfer.

xviii. The scheme shall have continuous comprehensive self-diagnostic feature to monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated.

xix. The scheme shall be a complete package in all respect including all software hardware etc, all auxiliary relays, individual high speed hand reset tripping relays for each feeder, indication lamps etc, if required.

xx. The scheme shall ensure that no region within the bus bar zone should be left unprotected by the offered bus bar scheme. Fault between isolator and CT in bus coupler section should be detected by the bus bar scheme.

xxi. The scheme shall include necessary software for CT ratio correction. No ICT etc. shall be allowed to be used.

xxii. The bus bar protection scheme should be equipped with IRIG B Port.

xxiii. It shall include continuous supervision of each DC supply separately.

xxiv. Test terminal block shall be fully enclosed with removable covers and shall be made of moulded, non-inflammable good quality material with boxes barriers molded integrally. Adequate number of Test handles shall also be provided with test blocks to facilitate complete testing.

xxv. The Bus Bar protection scheme shall have 3 phase Bus PT inputs from both PTs.

xxvi. The scheme should not trip for the differential current below the load current of heaviest loaded feeder. This feature should be provided with enable/disable option.

xxvii. The scheme shall provide on the unit and should be accessible for checking of the menu, setting and DR etc at least in the following way:

(a) HMI on the front of the relay. The bus bar protection scheme shall have a large HMI in the front capable of displaying bay current and all calculated differential current etc.

(b) The relay should display the menu, setting, DR & ER etc. through the keyboard provided on the front of the relay.

(c) The scheme should have RS232/LAN port on the front of the panel for accessing by using personal computer to go through the menu, Setting measurements and disturbance records and dynamic bus bar replica etc. This may be on the propriety protocol. The associated software shall be supplied along with the

relay.

(d) It should be provided with suitable port so that all the relays in the system could be brought on the common bus and connected to a common computer available in the S/S for communication for accessibility of menu, disturbance records, event record and bus bar replica etc.

xxviii. The numerical relay should have in built breaker failure with 3 phase LBB initiation scheme with the operation and resetting time not more than 20 milli second. The relay shall have adjustable time delay of 100 to 500 ms with tripping time delay of relay not more than 20 milli second.

Auxiliary relays, trip relays, switches etc. if required to facilitate the operation of the scheme shall be fully covered in the scope of supply.

xxix. All the Busbar panels shall be suitable for at least 24 (twenty four) Number of bays.

xxx. The number of analog inputs & digital inputs should be sufficient for 24 number of bays required in the bus bar protection panel.

xxxi. The scheme should be capable to monitor minimum 80 number Isolators and to provide individual alarm for each Isolator.

17.3 **DC Supply supervision Relays:**

Separate Dc supply supervision relay, one each for the main and duplicate 220 V DC supply system shall be provided for Bus Bar panels. Scheme shall be capable of monitoring failure of DC supply of the circuit to which it is connected. It shall have adequate potential free contacts to meet out the requirement of the scheme and also to meet the requirement for providing alarm and facia indication. The scheme shall have a "time delay on drop off" of not less than 100 m. sec. and be provided with operation indicator/ flag. This relay shall should AC 230V heavy duty bell with provision for accept/ reset and test facilities.

High speed tripping relays:

Adequate number of electrically resettable high speed tripping relays will be provided for extension of tripping command from bus bar protection scheme to the existing Bus bar trip relay provided for each 400 KV Bay. This relay will have adequate number of NO/NC contacts suitable for 220V Dc voltage as per offered scheme requirement as per scheme. These relays1 shall have following features:

(a) High speed operation,
(b) High degree mechanical stability,
(c) Compact.
(d) Self Monitoring type

The type and number of tripping relays and its NO/NC contacts shall be subject to approval by CSPTCL as per the scheme submitted by the bidder. These trip relays shall have at least 20 % spare contacts over that utilized in the scheme.

Relay Test Accessories to be provided with BusBar Protection panels

22.1 One relay test kit shall comprise of the following equipment as detailed here under

Relay tools kits -3 sets
Test plugs – 6 Nos.

18. TIME SYNCHRONISATION EQUIPMENT

18.1 The Time synchronisation equipment shall receive the co-ordinated Universal Time (UTC) transmittedthrough Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.

18 .2 Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

18 .3 It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

18.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.

18.5 The synchronisation equipment shall have accuracy better than 500 ns. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, &temperature variations, propagation & processing delays etc).

18.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.

18.7 The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

18.8 The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

18.9 The equipment offered shall have four (4) spare output ports over and above required ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following :

- Voltage signal : Normally 0-5V with 50 milli Seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
- Potential free contact (Minimum pulse duration of 50 milli Seconds.)
- IRIG-B
- RS232C

18.10 The equipment shall have a periodic time correction facility of one second periodicity.

18.11 Time synchronisation equipment shall be suitable to operate from 220V DC

18.12 Equipment shall have real time digital display in hour, minute, second (24 hour mode) &have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 mm height.

19 TYPE TESTS

19.1 The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator, Disturbance recorder and Event Logger The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

a) Insulation tests as per IEC 60255-5
b) High frequency disturbance test as per IEC 60255-4
c) Fast transient test as per IEC 1000-4, Level III(not applicable for electromechanical relays)
d) Relay characteristics, performance and accuracy test as per IEC 60255
   - Steady state Characteristics and operating time
   - Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
   - For Distrubance recorder and Event logger only performance tests are intended under this item.
e) Tests for thermal and mechanical requirements as per IEC 60255-6
f) Tests for rated burden as per IEC 60255-6
g) Contact performance test as per IEC 60255-0-20

19.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A on simulator/network analyser/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out the

above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

20 CONFIGURATION OF RELAY AND PROTECTION PANELS

S. No.	Protection Schemes	315 MVA X'mer		400 KV feeder bay	400KV Tie Bay	400KV Reactor bay	220 KV Feeder bay	220 KV Bus Coupler Bay	33 KV Station Transformer bay
		400 KV Side	220 KV Side						
1	Bay Control Unit	2	2	2	2	2	2	2	2
2	Numerical Differential Protection relay	2	Nil	Nil	Nil	1	Nil	Nil	Nil
3	Numerical DPR relay	Nil	Nil	2	Nil	1	2	Nil	Nil
4	Over fluxing relay	1	Nil	Nil	Nil	NIL	NIL	NIL	NIL
5	Two stage Over voltage Protection	In built	Nil	Inbuilt	Nil	NIL	NIL	Nil	NIL
6	LBB relay	1	1	1	1	1	1	1	1
7	Trip circuit supervision relay	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets.	2 Nos.	2 Nos.
8	220 VDC supply voltage monitoring relay	2 sets	2 sets	2 sets	2 sets	2 sets.	2 sets	2 sets	2 sets
9	PT fuse failure relay	Nil	Inbuilt	Inbuilt	Nil	In built	In built	Nil	Nil
10	Auto Reclose relay	Nil	Nil	1	1	Nil	1	Nil	Nil
11	Neutral displacement relay	Nil	NIL	NIL	Nil	NIL	NIL	Nil	1
12	Numerical Directional O/C and E/F relay with high set	1	1	1	Nil	Nil	1	2	1

S. No.	Protection Schemes	315 MVA X'mer		400 KV feeder bay	400KV Tie Bay	400KV Reactor bay	220 KV Feeder bay	220 KV Bus Coupler Bay	33 KV Station Transformer bay
		400 KV Side	220 KV Side						
13	Synchronising Scheme	Inbuilt in BCU	Inbuilt in BCU	Inbuilt in BCU	Inbuilt in BCU	Inbuilt in BCU	Inbuilt in BCU	Inbuilt in BCU	Nil
14	Over load Protection	1	Nil	Nil	Nil	NIL	NIL	NIL	NIL
15	Self reset type High speed Single Phase trip Relays (phase segregated)	2 sets	NIL	2 sets	Nil	2 sets	2 sets	-	Nil
16	Lock out trip relay Electrically reset Type	2 Sets.	2 Sets	2 Sets	Nil	2 Sets	2 Sets	2 Sets	2 Sets
17	Bus Bar Trip relay Electrically reset type	1	1	1	Nil	Nil	1	1	1
18	Transformer/Reactor body protection relays.	1 Set	NIL	Nil	Nil	1 Set	NIL	NIL	1 set
19	REF Relay	1	Nil	Nil	Nil	1	Nil	Nil	Nil
20	Ethernet Switch	Minimum Two Ethernet switches per Bay Marshalling Room (shall comply with requirement of PRP or HSR topology)							
21	Auxiliary relays	As per requirement							
22	Bus Bar Protection scheme	A)For 400 KV - Two physically Independent Bus bar protection units each having Main and check Zones for each 400 KV Bus of One and half breaker Bus bar scheme B)For 220 KV - Two physically Independent Bus bar protection units each having Main and check zones for Two Main Bus and a Transfer Bus scheme. One no. protection unit is already existing in 220 S/s the integration of proposed bay is to be done as per specifiactions.							
23	Trip transfer switch	Nil	1	Nil	Nil	Nil	1	NIL	NIL
24	TNC switch	1 No.	1 No.	1 No	1 No	1 No.	1 No.	1 No.	1 No.
25	**SEMS make APEX ABT meter Energy Meter 3 Phase 4 wire (True four quadrant)**	2	2	2	Nil	Nil	2	NIL	2

21. ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

22. TROPICALISATION

Control room will be normally air-cooled/air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and otherharmful effects due to tropicalenvironment.

23. ENERGY METERS: Panel shall have Secure make true four quadrant ,Exp/Imp, ABT type APEX energy meters as per the requirements of the purchaser with automatic downloading facility of data/reading from meter to PC over Ethernet and RS 485 port on DLMS and MODBUS protocol. The load survey and demand integration period must be 15 minuts and meter shall have provision to configure 15 or 5 minute time block. Automatic data logging facility shall be implemented at an independent PC workstation for all energy meters.

24. 2 No. laptops shall be provided with C&R Panels. **All the software interphases of the relays and energy meters are to be provided.**Specifications for Operating/Data Extraction/Analysis Device **alongwith with interface cable for 400KV S/s.**Necessary software and hardware to up load /down load the data to/from the relay from/to the Data Extraction Device.Operating/Data Extraction/Analysis Device having following specifications or better; Powered by 5th Generation Intel® Core i5-5200U Processor with Windows 8.1 Single Language (64Bit) English, RAM - 8GB Dual Channel DDR3L 1600 MHz (4GBx2), Hard Drive - 1TB 5400 rpm, Display : 15.6-inch HD (1366 x 768) Truelife LED-Backlit Touch Display, Video card : AMD Radeon™ R7 M270 4GB DDR3,Ports/slots-USB 3.0 with Power Share (1), USB 3.0 (1), USB 2.0 (1) HDMI™ v1.4a, Combination headphone/ microphone jack Noble Lock Slot AC Power In, Multi-media Card Reader - Digital (SD) Memory Card, Secure Digital High Capacity (SDHC), Secure Digital Extended Capacity (SDXC), Power - Prismatic (58 WHr) Lithium Ion, Security Software-McAfee® Security Center 15 month subscription, Warranty - 1Yr ProSupport: Next Business Day Onsite Service w/ Accidental Damage

Technical Specification for Visual Monitoring System

Visual monitoring system for watch and ward of Substation premises

At present there is the visual monitoring system of 10 no. visual camera make M/s hikvision at 220/132 KV Dhardehi. A new visual monitoring system shall be supplied, erected and commissioned in new control room building .It shall be the responsibility of the contractor to provide necessary arrangement for integration of visual cameras of existing 220 KV substation Dhardehi and proposed 400 KV substation Dhardehi in new control room building. The existing PC, server and furniture of old control room shall be utilised by CSPTCL after successful commissioning of new visusal monitoring system.

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

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

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

1 The operation of each and every isolator pole of the complete yard (including future scope)
2 All the transformer and reactors (Including future scope)
3 All the entrance doors of control room building and fire fighting pump houseand switchyard panel room.
4 All the gates of switchyard.
5 Main Entrance gate
6. All other Major Equipments (such as CB, CT, CVT, LA etc. for present and future)

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

1.1 Technical requirements of major equipment of Visual Monitoring System

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

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

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

1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable

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

1.2 **System requirements**

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

b) All cameras may be connected through a suitable LAN which shall be able to perform in 400 kV class sub-station environment without fail

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

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

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

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

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

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

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

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

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

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-12
3. AC Voltage Dips & Interruption/Variation (level 4) – As per IEC 61000-4-12
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC Power Supply (level 4) – As per IEC 61000-4-17

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

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

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

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

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

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

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

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

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

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

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

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

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 6 GB RAM, 3000GB HDD (min)), RAID 5 with suitable configuration along with Colored TFT 29" High resolution monitor, and Internal DVD writer. Windows XP/ Vista/7 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

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

1. Server Spec Intel Quad Core (or better) 3.0 Ghz(min.) , 8 MB Cache , 6 GB memory or better , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2. Recording and Display Real-time 25 frames per second perFrame Rate channel , manual select
3. Recording Resolution (PAL): 1280X720, 704(H) x 586(V) It should be possible to

select lower Resolutions

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

1.2.3 VMS Camera

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

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

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

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

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

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

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

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

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

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

1. Image Sensor 2-megapixel Progressive ,1 / 3" CMOS/CCDsensor, Minimum illumination 0.1 Lux (or better)
2. Min Luminous 0.5LUX(Color) 0.05Lux(Black)
3. Camera Enclosure Type IP66 Grade
4. Iris/Focus Auto/Manual
5. Video Compression Dual Stream H.264 and MPEG 4 user selectable

6. Support Dual-stream primary/secondary stream, H.264/MPEG 4Optional
7. Video Definition Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8. Video Parameters Brightness, hue, contrast, saturation and image quality
9. Video Frame Rate PAL: 1-25frames/second NTSC:1-30frames/second
10. Video Compression BR 32Kbit/S - 6Mbit/S
11. Video Output One channel composite Streaming
12. Supported Protocols TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13. Operating Temperature-5 ~ +50
14. Operating Humidity 10 ~ 90%

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

1. Image sensor1/3 type Solid State Progressive ScanCCD,WDR(High Definition)
2. Security Multiple user access with password protection
3. Effective Pixels **(PAL): Main Stream 1280x720**Sub Stream 640x360 320x280 selectable
4. Compression Dual Stream H.264 and MPEG 4 user selectable
5. Signal System 50 Hz
6. S/N (signal to noise) Better than 50 dB Ratio
7. Electronic Shutter 1/60 ~ 1/10,000 sec. automatic or better
8. Scanning System Progressive/interlace
9. Low Light Sensitivity Color: 0.5 Lux; B&W:0.02 Lux (lux)
10. LensMinimum10x(minimum)opticalinHigh Definition

(**The system shall be able to zoom theimages on the monitor without any distortion to the maximum level of optical zoom)**

11. Lens Size Minimum 4.1~73.8 mm
12. Lens Aperture F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus
    Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13. PTZ Data Transfer Selectable 2400 bps / 4800 bps / 9600 bps Baud/Bit Rates Supported
14. Panning Range Complete 360 degrees (horizontal)
15. Pan Speed Adjustable, 0.1 degrees / second ~ 250degrees / second
16. Tilting Range Minimum 180° Tilt Rotation
17. Tilt Speed Adjustable, 0.1 degrees / second ~ 150degrees / second
18. In Built Storage Camera should have inbuilt storage TF or SDformat for recording and storing Pictures
19. IP Class IP66 Standard
20. Working temperature -0 ~ +50
21. Working Humidity 10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include

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

1. Key Application wired keyboard control operation of PTZ functions for weatherproof dome cameras

2. Pan / Tilt / Zoom SelectableProtocol LanguagesSupported
3. PTZ Data Transfer selectable 1200 bps / 2400 bps /4800 bps/Baud Rates 9600 bpsSupported
4. Additional Features dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

GI STRUCTURES

1.0 GENERAL

1.1 The scope of specification covers Design, fabrication, proto-assembly, supply and erection of galvanised steel structures for towers, girders,lighting high masts and equipment support structures.All equipment support structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806 .

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

The connection of all structures to their foundations shall be by base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 0.6 10 kg/m2 for anchor bolts / foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the standard structure fabrication drawings. Drawings of fixing of such accessories shall be submitted by the Contractor for approval.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES

2.1 For design of steel structures loads such as dead loads, live loads, windloads etc. shall be based on IS:875,Parts I to V. The steel structures shall be designed for a Wind Zone III.

2.2 For materials and permissible stresses IS:802,Part-I,Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

2.3 Minimum thickness of galvanized tower member shall be as follows :

Member	**Minimum thickness (mm)**
Leg members, Peak members/Main members	5
Other members	4
Redundant members	4

2.4 Maximum slenderness ratios for leg members, other stressed membersand redundant members for compression force shall be as per IS-802.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 **Step Bolts**

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the top of the tower. The step bolt shall conform to IS: 10238.

2.8 **DesignCriteria**

All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS: 1893 (latest),Importance factor of 1.5, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 50.0 kA. IEC-865 may be followed for evaluation of short circuit forces.

a) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.
   Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of switchyard structures.

b) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

c) **Terminal/line take off gantries** shall be designed for a minimum conductor tension of 4 metric tonnes per phase for 400 KV and 2 metric tonnes per phase for 220 KV, or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 200 metres. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

d) The girders shall be connected with lattice columns by bolted joints.

e) All Pipe support used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS:1161 read in conjunction with IS:806.

g) If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

h) Foundation bolts shall be designed for the loads for which the structures are designed.

3.0 DESIGN DRAWINGS, BILL OF MATETRIALS & DOCUMENTS

3.2.1 The Contractor shall furnish design, drawing and BOMs and shop manufacturing drawings for every member to the owner after award of the Contract. The design drawing should indicate not only profile but section, numbers and sizes of bolts and details of typical joints. In case CSPTCL feels that any design drawing, BOM are to be modified even after its approval, Contractor shall modify the designs & drawings and resubmit the design drawing, BOM as required in the specification

3.2.2 The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the owner. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the owner. The fabrication

drawings shall be submitted to the owner. Proto shall be made only after approval of fabrication drawings.

3.2.3 Such approval shall, however, not relieve the Contractor of his responsibility for the safety of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

3.3 The Mass fabrication work shall start only after the final approval to the proto corrected Fabrication drawing is accorded by the owner. Protoassembly shall be required to be carried out only for those structures that have not been proto-assembled by the same fabricators for this contract or for earlier contracts from CSPTCL. Wherever proto-assembly is not to be repeated, proto-corrected drawings shall be submitted directly with a note on the drawing stating that proto-assembly has been carried out under a particular previous contract.

4.0 FABRICATION OF STEEL MEMBERS

4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provision in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

5.0 PROTO-ASSEMBLY

i) The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

ii) Sample towers, beams and equipment support structures shall be trial assembled in the fabrication shop and shall be inspected and cleared by Contractor based on the approved fabrication drawing before mass fabrication. Owner may opt to witness such trial assembly.

For all structures, B.O.Ms along with proto corrected fabrication drawings shall be prepared and submitted to owner as document for information. Such BOM, which shall be duly certified by the Contractor for its conformity to the drawings issued by Owner, shall be the basis for owner to carry out inspection.

6.0 BOLTING

i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

ii) All steel items, bolts, nuts and washers shall be hot dip galvanised.

iii) 2.0% extra nuts and bolts shall be supplied for erection.

7.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld etc. Symbols for welding on erection and shop drawings shall be according to IS:8 13. Efforts shall be made to reduce site welding so as to avoid improper joints due to constructional difficulties.

8.0 FOUNDATION BOLTS

8.1 Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast.

The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

8.2 The Contractor shall be responsible for the correct alignment and levelingof all steel work on site to ensure that the towers/structures are plumb.

8.3 All foundation bolts for lattice structure, pipe structure are to be suppliedby the Contractor.

8.4 All foundation bolts shall be fully galvanised so as to achieve 0.61 kg. perSq.m. of Zinc Coating as per specifications.

8.5 All foundation bolts shall conform to IS 5624 but the material, howevershall be MS conforming to IS:2062.

9.0 STABILITY OF STRUCTURE

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

10.0 GROUTING

The method of grouting the column bases shall be subject to approval of owner and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. The Contractor will be fully responsible for the grouting operations.

11.0 GALVANISING

11.1 All structural steel works and pipe supports shall be galvanised after fabrication.

11.2 Zinc required for galvanising shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.95% as per IS:209.

11.3 The Contractor shall be required to make arrangement for frequent inspection by the owner as well as continuous inspection by a resident representative of the owner, if so desired for fabrication work.

12.0 TOUCH-UP PAINTING

The touch up primers and paints shall consist of Red Oxide / Zinc chromate conforming to the requirements of IS:2074 with a pigment to be specified by the owner.

13.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by CSPTCL or its authorised representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

14.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be forwarded to the owner.

15.0 ERECTION

The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage.

16.0 MODE OF MEASUREMENT

The measurement of the standard lattice structures for towers, beams etc. shall be made in weight(MT) for each type of structure. The measurement of equipment support structure etc. shall be made in numbers for each type of structure. This will include foundation bolts and nuts and therefore no separate payment shall be made for the same. The unit rate quoted shall be inclusive of supply, fabrication, galvanizing, erection, nuts, bolts, wastages etc. complete. Nothing extra shall be payable for substitution necessitated due to non-availability of sections indicated in the standard

drawing. Nothing extra shall be payable for modifications or steel added to suit the contractors fixing arrangements for accessories etc.

The measurement of the non-standard lattice and pipe structure of tower structure, beam, equipment structure etc. shall also be measured in MT including the weight of foundation bolt. The unit rate quoted shall be inclusive of supply, fabrication, galvanizing, erection, nuts, bolts, (excluding foundation bolts), washers, wastages etc complete.

17.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.

18.0 All tests mentioned in standard field quality plans have to be carried out and conformity of materials and workmanship shall be ascertained.

GEOTECHNICAL INVESTIGATION

1.0 GENERAL

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate, general as well as specific information about the soil profile and the necessary soil parameters of the Site in order that the foundation of the various structures can be designed and constructed safely and rationally.

A report to the effect will be submitted by the Contractor for Owner's specific approval giving details regarding data proposed to be utilised for civil structures design.

The Contractor may visit the site to ascertain the soil parameters. Any variation in soil data shall not constitute a valid reason for any additional cost & shall not affect the terms & conditions of the contract.

2.0 SCOPE OF WORK

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

All the work shall be carried out as per latest edition of the corresponding Indian Standard Codes.

2.1 Bore Holes

Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 10meter depth or to refusal which ever occur earlier shall be drilled. In any case number of boreholes shall not be less than five. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. Number of boreholes may be increased in case soil strata is varying from borehole to borehole in order to have fair idea of soil profile. In case of deep pile foundations soil investigation is to be carried out up to 25 m depth from ground level or refusal whichever is earlier. In case rock is encountered, coring in all the boreholes shall be carried out up to 3 meter in rock.

Performing Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 0.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 0.5 m below ground level onwards in clayey strata.

The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.

All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.

The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor's laboratory without any damage or loss.

The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-change.

2. 2 Trial Pits

Trial pits shall be carried at specified one locations per Hectare as directed by the Owner. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Owner. Undisturbed samples shall be taken from the trial pits as per the direction of the Owner.

2.3 Electrical Resistivity Test

This test shall be conducted to determine the Electrical resistivity of soil required for designing safety-grounding system for the entire station area. The specifications for the equipments and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to IS:3043. The test shall be conducted using Wagner's four electrode method as specified in IS : 1892, Appendix-B2. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.2 m upto a distance of 50.0 m.

2.4 Plate load test

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

(a) One at Control Room Building location at the proposed foundation depth below finished ground level for bearing capacity.

(b) One at camping house area

Undisturbed tube samples shall be collected at 1.0 m and 2.5m depths from natural ground level for carrying out laboratory tests.

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

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

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

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

2. 5 Water Sample

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

2.6 Back Filling of Bore Holes

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

2.7 Laboratory Test

1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples have reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.
2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid out in the relevant I.S. Codes.

   The following laboratory tests shall be carried out

   a) Visual and Engineering Classification
   b) Liquid limit, plastic limit and shrinkage limit for C-Ø soils.
   c) Natural moisture content, bulk density and specific gravity.
   d) Grain size distribution.
   e) Swell pressure and free swell index determination.
   f) California bearing ratio.
   g) Consolidated drained test with pore pressure measurement.
   h) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
      i) In case of rock samples following tests shall also be conducted:
      (i) Rock quality designation (RQD), RMR.
      (ii) UCC test.
      (iii) Point load index test.

2.8 Test Results and Reports

2.8.1 The Contractor shall submit the detailed report in two (2) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the contractor shall submit draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The test data shall bear the signatures of the Investigation Agency, Vendor and also Engineer in charge of CSPTCL.

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

a) A plan showing the locations of the exploration work i.e. bore holes, dynamic cone penetration tests, trial pits. Plate load test etc.
b) Bore Logs : Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

Test results of field and laboratory tests shall be summarised strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs,

if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.

2.8.3 **Recommendations :**

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

a) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.

b) Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.

c) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 3.0 (three). Recommendation of liquefaction characteristics of soil shall be provided.

d) Recommendations regarding slope of excavations and dewatering schemes.

e) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.

f) If expansive soil is met with, recommendations on removal or retainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification or materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.

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

h) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given.

TECHNICAL SPECIFICATION FOR FIRE PROTECTION SYSTEM

This fire protection System shall be provided for 315 MVA, 400/220/33 KVPower Transformers, 50 MVAr Shunt reactor and 3 MVAR NGR.

1.00.00 **INTENT OF SPECIFICATION**

This section covers the design and performance requirements of the following types of fire protection systems;

a. Hydrant System
b. High Velocity Water (H.V.W) Spray System
c. Fire Detection System
d. Portable Fire Extinguishers
e. Wheel/ Trolley mounted Fire Extinguishers

1.00.01 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.

1.00.02 The scope of work includes construction of trenches for housing of pipes , complete earthwork (i.e. excavation, backfilling etc.) for the buried section of piping for the system, valve pits and pipe supports for buried, entrenched and overground piping.

1.00.03 The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved international standards shall meet the requirement called for in the latest revision of relevant Indian Standard or shall be superior.

1.00.04 Ambient temperature for design of all equipment shall be considered as 50°C.

2.00.00 **DESIGN AND CONSTRUCTION**

2.01.00 **Hydrant System**

Hydrant system of fire protection essentially consists of a large network of pipe, partly underground & majorly entrenched over ground which feeds pressurised water to a number of hydrant valves, indoor as well as outdoor. These hydrant valves are located at strategic locations near buildings, Transformers.Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be provided for the following in the substation.

a) Control room building
b) D.G. set building
c) Aux. power supply Transformer area.
d) Fire Fighting pump House.
e) Stores
f) Transformers
g) Bay Marshalling Rooms

2.01.01 A warning plate shall be placed near the hydrant points for the transformers and the pump in substations to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer which is on fire is switched off and there are no live parts within 20metres of distance from the personnel using the hydrant.

2.02.00. **HIGH VELOCITY WATER (H.V.W) SPRAY SYSTEM**

H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this system. This shall be

provided for transformers in 400kV substations. Wet detection initiation system shall be employed for automatic operation.

The system shall be designed in such a way that the same can be extended to protect additional Transformer/ Reactor to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer will be on fire. The system shall be designed to have a pressure of 5.5kg/cm2 at 350m3/hr. at the farthest transformer/reactor location .

2.02.01 The Electrical clearance between the Emulsifier system pipe work and live parts of the protected equipment shall not be less than the values given below :

	20 kV Bushing	500 mm
	45 kV Bushing	150 mm
	2.5 kV Bushing	30 mm
4	5 kV Bushing	20 mm

2.02.02 Minimum water pressure available at the farthest and/or highest projector (H.V.W spray system) on the equipment protected shall be 3.5 kg/cm2(g). However, water pressure available at any projector shall not exceed 5.00kg/ cm2(g). Water shall be applied at a rate of 10.2 LPM/M2 of the surface area of the entire transformer including radiator, conservator, etc. (including bottom surface for transformer)

2.02.03 **Deluge Valve**

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor.

Each Deluge valve shall be provided with a local panel from which will enable manual electrical operation of the valve. In addition to this, each valve shall be provided with local operation latch.

Test valves shall simulate the operation of Deluge valves and shall be of

2.06.02 **Control Panel**

quick opening type. The general construction shall conform to requirements under clause no.7.00.00 for piping, valves and specialities.

2.02.04 **High Velocity Spray Nozzles (Projectors)**

High velocity spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity, which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling.

2.02.05 Minimum set point of the heat detectors used in the HVW spray system shall be 79°C. The optimum rating shall, however, be selected by the Bidder, keeping in mind the maximum and minimum temperature attained at site.

2.03.00 **Fire Detection System**

This system shall be provided for 400kV substations.

2.03.01 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the bay marshalling rooms and entire control room building, including corridor and toilets. Fire detectors shall be located at strategic locations in various

rooms of the building. The operation of any of the fire detectors/ manual call point should result in the following;

1. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
2. An audible alarm sounded in the panel,
3. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
4. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.
5. A signal shall be given to air conditioning system for its shut down.

2.03.02 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

2.03.03 Fire detectors shall be provided on ceiling as well as on false ceiling in conference room, on false ceiling in control room and relay room and on ceiling in all other areas. **Coverage area of each smoke detector shall not be more than 60 m^2 and that of heat detectors shall not be more than 40 m^2.**Ionisation type smoke detectors shall be provided in all areas pantry Room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.04.00 Portable and Wheel/ Trolley mounted Fire Extinguishers

2.04.01 Portable Fire Extinguishers

Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and DG set & FF building. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of pressurised water type, dry chemical powder type and Carbon dioxide type portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.05.00 **Water Supply System**

2.05.01 Water for hydrant & HVW system shall be supplied by one electrical motor driven pump with another pump, driven by diesel engine, shall be used as standby. Two nos. water storage tanks of total capacity 420 cu.m. shall be provided. Pumps shall work under positive suction head. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in 400 kV control room.

The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper clamping. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground as per Cl.no.7.04.05. Such locations shall be finalised during detailed engineering.

The whole system will be kept pressurised by providing combination of air vessel and jockey pumps. The capacity of air vessel shall not be less than 3m3. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. The pumps and air vessel with all auxiliary equipment will be located in firewater pump house.

Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.05.03 The design and construction of horizontal centrifugal pumps alongwith drives and accessories shall be in line with the requirements of Tariff Advisory Committee of India.

2.05.04 The technical specification of the diesel engine driven fire pump and electric motor driven fire pumps shall meet requirements as set in Data Sheet. The general design of the fire fighting pump sets shall meet the requirements under clauses no.5.00.00 for Horizontal centrifugal pumps and 12.00.00 for Electrical motors.

2.05.05 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.05.06 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements of clause no. 7.00.00.

2.06.00 **Instrumentation and Control System**

2.06.01 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause 11.00.00.The control and monitoring of the fire protection system shall be integrated into substation automation system by providing sufficient number of bay control units.

2.06.02 **Control Panel**

Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

a) Panel for motor driven fire water PumpThe panel shall be provided with

TPN switch	1
Auto/manual switch	1
Start/Stop Push buttons with indication lamp	1
DOL starter with thermal 0/L	1
Indicating lamp showing power ON	1
Indication lamp with drive	1
ON/OF	1
Indication lamp showing	1
Motor Trip	

Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.

b) Panel for Two nos. Jockey Pump 1No.

The panel shall be provided with the following:

1.	Fuse-switch unit for Jockey pumps	1 Set for eachpump
2.	Auto/manual switch for Jockey Pumps	1 No. each
3.	Selector switch for selecting either jockey pump	1 No. 1 No. each
4.	D.O.L. starter with overload relay self-resetting type, for all the drives.	1 Set for each jockey pump 1 No. each for
5.	Start/stop push button for Jockey Pump with indication lamp with pad-locking arrangements in stop position	all the drives.

6. Indication lamp for trip
Indication

c) Panel for 2 Nos. battery charger & Diesel Engine driven fire water pump — 1 No.

The panel shall be provided with the following :

1	Auto/Manual switch for Diesel Engine driven pump	1 No.
2	Start/Stop push buttons with indication lamp	1 Set
3	Indicating lamp showing drive ON/OFF	1 Set
4	D.C. Voltmeter/Ammeter in the battery charger circuit	
5	Battery charger will be as per specification described	
6	Selector switch for selecting either of battery chargers for the battery sets.	
7	Selector switch for selecting either set of batteries for	
8	Diesel engine starting.	
9	Selector switch for boost charging/trickle charging of battery set	

d) Individual local control panel is to be considered for each transformer deluge system wherever these equipment are envisaged. This panel shall contain push buttons with indicating lamps for spray ON/OFF operation in the valve operation circuit. Push buttons shall be concealed behind glass covers, which shall be broken to operate the buttons. Provision shall be made in the panel for the field signal for the annunciations such as spray ON and fire in the Transformer. A signal for spray ON shall also be provided in the control room fire alarm panel for employer's SAS/event logger.

2.06.03 **Annunciation Panels**

a) **Location : Fire Water Pump House**

i) Indicating lamps showing power supply "ON" and status indication lamps for each motor.

ii) Annunciation windows complete with buttons. Details are as given below :These are also to be logged in substation automation sy

Sl.No.	Description	Number
1.	EElectric motor driven fire water pump running	1
2.	Electric motor driven fire water pump fails to start	
3.	Diesel engine driven fire water pump running.	
4.	Diesel engine driven water pump fails to start	
5.	Jockey pump-1 running	
6.	Jockey pump-1 fails to start	
7.	Jockey pump-2 running	
8.	Jockey pump-2 fails to start	
9.	Fire in Transformer	1 for each

		equipment
10.	Deluge system operating for Transformer	1 for each equipment
11.	Fire fighting System in operation/ Header pressure low	1
12.	Fire in smoke detection system zone	1
13.	Water storage tank water level low	2
	High speed diesel tank level low	1
15	Spare	10

b) Location 400 kV Control Room

i) Indication lamp showing power supply 'ON'

ii) Provision shall be made in the panel for a signal for spray ON for each Transformer for owner's use for SAS/event logger.

iii) Following annunciations shall be provided.in annunciation panel as well as SAS of the system

Sl.No.	Description	Number
1.	Fire in Transformer	1 for each equipment
2.	Diesel engine driven fire water pump in operation	1
3.	Motor driven fire water pump in operation	1
4.	Fire fighting Water storage tank level Low	2
5.	Fire/Fault	1+1(duplicate)For each zone as applicable
6.	Spares	10

c) Each annunciation panel shall be provided with a hooter.

d) Indication for fault in respective areas shall also be provided. Each annunciation window shall exhibit 'FIRE' and 'FAULT' conditions separately.

2.06.04 The control and interlock system for the fire protection system shall meet the following requirements:

1. Electric Motor Driven Fire water Pump

Pump should start automatically under any of the following conditions:

a) HVW spray or Hydrant system header pressure low.

b) Operation of any deluge valve Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

2. Diesel Engine Driven Standby Pump

The pump should automatically start under any of the following conditions:

a) Header pressure low.

b) Electric motor operated fire water pump fails to start. Pump should be stopped manually only.Pump should also be started manually if required from the local control panel.The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. **Jockey Pump**

Jockey pump shall start automatically when water pressure in header falls below the set value. Jockey pump shall stop automatically when the pressure is restored to its normal value.

Manual starting/stopping shall be possible from the local control panel.

3.00.00 **SHOP AND SITE TESTS**

3.01.00 **Shop Tests**

3.01.01 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be

3.01.02 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall include but not be limited to the tests described as follows :

a) Materials analysis and testing.
b) Hydrostatic pressure test of all pressure parts, piping, etc.
c) Dimensional and visual check.
d) Balancing test of rotating components.
e) Determination of performance characteristics of pumps, compressors, diesel engines, electrical drive motors, etc.
f) Response characteristics of heat/smoke detectors.
g) Performance characteristics of HVW spray nozzles (projectors).
h) Temperature rating test on Heat detectors.
i) Flow rate and operational test on Flow control valves.
j) Operational test of alarm valve (water-motor gang).
k) Calibration tests on instruments and tests on control panel.
1) Destruction/burst tests on 2% or minimum one (1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.
m) Performance test on fire extinguishers as required in the code.

3.01.03 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.01.04 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and leveling.

3.01.05 All test certificates and reports shall be submitted to the Employer for approval.

3.01.06 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.02.00 **Site Tests**

3.02.01 **General**

a) All piping and valves, after installation will be tested hydraulically at pressure of 1.5 times that of the maximum attainable pressure in the system to check against leak tightness.
b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.
c) All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.
d) All pressure vessels should be tested hydraulically at the specified test

pressure, singly or in the system.

e) Painting shall be checked by dry type thickness gauges.

f) Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.

g) All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.

h) Automatic starting of all the fire pumps by operating the test valves.

i) Automatic operation of the Jockey pump

i) Operation of the automatic flow control valve by operating the test valve and remote operating of the solenoid valve.

k) Operation of entire annunciation system.

3.02.02 After erection at site, the complete HVW spray protection and hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval. It shall be in line with standard Performance Guarantee Test procedure enclosed at Appendix-I.

3.02.03 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4.00.00 **SPARE PARTS**

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in `Section - Projects'.

5.00.00 **HORIZONTAL CENTRIFUGAL PUMPS**

This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of fire fighting.

5.01.00 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

5.01.01 In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail. In case of contradiction between this specification and "horizontal centrifugal pump data specification sheets" enclosed, stipulations of the data specification sheets will prevail.

5.02.00 **General Performance Requirements**

5.02.01 The pump set shall be suitable for continuous operation at any point within the "Range of operation".

5.02.02 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.02.03 Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.02.04 The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any maloperation of the system.

5.02.05 **Drive Rating**

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified where the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

5.02.06 During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

5.02.07 Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards.

5.02.08 The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.03.00 **Design &Construction**

5.03.01 Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

5.03.02 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.

5.03.03 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.03.04 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

5.03.05 **Impeller**

The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the saft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.

5.03.06 **Wearing Rings**

Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.

5.03.07 **Shaft**

Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be atleast 10% away from runaway speed.

5.03.08 **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

5.03.09 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

5.03.10 **Bearings**

Bearings and hydraulic devices (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

Bearings shall be easily accessible without disturbing the pump assembly.

A drain plug shall be provided at the bottom of each bearing housing.

5.03.11 **Stuffing Boxes**

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.03.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.03.13 **Base Plates &Sole Plate**

A common base plate mounting both for the pump and drive shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.03.14 **Balancing**

All rotating components shall be statically and dynamically balanced at shop.

5.03.15 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.03.16 **Prime Mover**

The design and construction of the electric drive motor shall be as specified in clause

5.04.00 **Tests and Inspection**

5.04.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.04.02 Where stage inspection is to be witnessed by Employer, in ddition to above, the Bidder shall submit to the Employer/Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.04.03 **Material of Construction**

All materials used for pump construction shall be of tested quality. Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

5.04.04 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.

5.04.05 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.

5.04.06 **Hydraulic test at shop**

All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.

5.04.07 **Performance test at shop**

Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the Hydraulic Institute Standards/ASME Power Test Code PTC 8.2/BS- 599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.04.08 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.

5.04.09 Tests shall preferably be conducted alongwith the actual drives being supplied.

5.04.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

5.04.11 In case of model testing, the stipulations of latest edition of Hydraulic Institute Standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.

5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.

5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.04.14 After installation, pumps offered may be subjected to testing at field also by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for site testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

5.04.15 If desired by the Employer, the Contractor shall conduct necessary model test for establishing optimum sump dimensions/flow correcting devices in existing sump, to suit the pump offered.

5.04.16 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.04.17 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

6.00.00 **DIESEL ENGINES**

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of fire fighting.

6.01.00 **Design and Construction**

General

6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.01.02 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.01.03 Reference conditions for rated output of engine shall be as per IS:10000, part II or ISO:3046, part I.

6.01.04 The engine shall be designed with regard to ease of maintenance, repair,cleaning and inspection.

6.01.05 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.01.06 **Starting**

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP.

Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.01.07 If provision for manual start (cranking) is provided, all controls/ mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.01.08 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batters. The automatic starting arrangement shall include a 'Repeat Start' feature. The battery capacity shall be adequate for 10 (ten) consecutive starts without recharging with a cold engine under full compression.

6.01.09 The batteries shall be used exclusively for starting the diesel engine and be kept charged all the time in position. Arrangement for both trickle and booster charge shall be provided.

Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.01.10 For detail design of battery and battery charger, sub- section Electrical may be referred to.

6.01.11 **Governing System** :

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.01.12 The governor shall offer following features :

a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

b) Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol. II, NFPA, 1978).

6.01.13 The governor shall be suitable for operation without external power supply.

6.01.14 **Fuel System**

The diesel engine will run on High Speed Diesel.

6.01.15 The engine shall be provided with fuel oil tank having adequate capacity to hold sufficient fuel oil for a minimum of ten(10) hours of full load run. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

6.01.16 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

6.01.17 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.

6.01.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be

incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

6.01.19 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.

6.01.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.01.21 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurised oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.

6.01.22 **Cooling Water System**

Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.

6.02.00 **Testing** &**Inspection**

The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.

At manufacturer's works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.

Material analysis and testing.

Hydrostatic pressure testing of all pressure parts.Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level. MPI/DPT on machined parts of piston and cylinder. Ultrasonic testing of crankshaft and connecting rod after heat treatment.Dimensional check of close tolerance components like piston, cylinder bore etc.

Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.Over speed test of the assembly at 120% of rated speed.Power run test.Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.

Measurement of vibration & noise.

(i) Measurement of vibration

The vibration shall be measured during full load test as well as during the overload test and limit shall be 100 microns.

(ii) Measurement of noise level

The equivalent 'A' weighted sound level measured at a distance of 1.5 M above floor level in elevation and 1.0 M horizontally from the base of the equipment, expressed in dB to a reference of 0.0002 microbar shall not exceed 93 dBA.

Adjustment of speed governor as per BS:5514.

Diesel engine shall be subjected to routine tests as per IS:10000/B S:5514.

7.00.00 **PIPING, VALVES AND SPECIALITIES**

This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

Scope

The piping system which shall include but not be limited to the following :

Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.

Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

Instrument tapping connections, stubs etc.

Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.

Basket strainers and Y-type strainers Bolts, nuts, fasteners as required for interconnecting piping, valves and fittings as well as for terminal points. For pipe connections into Owner's R.C.C. works, Bidder will furnish all inserts.

Painting, anti-corrosive coatings etc. inside and outside pipes and equipment.

Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.03.00 **Design**

7.03.01 Material of construction of various pipes shall be as follows :

(a) **Buried Pipes**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above) suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

(b) **Overground Pipes normally full of water**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes for sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above).

(c) **Overground pipes normally empty, but periodic charge of waterand for detector line for HVW System.**

Mild steel galvanised pipes as per IS:1239, Part-I medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (forpipes of sizes 200 NB and above).

7.03.02 All fittings to be used in connection with steel pipe lines up to a size of 80 mm shall be as per IS:1239. Part-II Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from IS:1239 Heavy grade pipes or steel plates having thickness not less than those of IS:1239 Part-I Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated from IS:3589 Class-2 pipes. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.03.03 Pipelines carrying water, air etc. should be sized on the basis of allowable velocities based on the rated capacity of the pumps.

7.03.04 For steel pipeline, welded construction should be adopted unless specified otherwise.

7.03.06 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.03.09 Gate/sluice valve will be used for isolation of flow in pipe lines and shall be as per IS:778/BS-5150 (for size upto 40 mm), IS:780 (for sizes above 40 mm and upto 300 mm) and IS:2906 (for sizes above 300 mm). Valves shall be of rising spindle type. PN 1.6 class valves shall be provided.

7.03.10 Gate Valves shall be provided with the following :
Hand wheel.
Position indicator.
Draining arrangement of valve seat.
Locking facility (where necessary).

7.03.11 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.03.12 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.

7.03.13 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid. These valves shall generally conform to IS:5312.

7.03.14 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform hand wheel with floor stand or chain operator shall be provided for the same.

7.03.15 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.03.14 **Strainers**

Basket Strainer

a) Basket strainers shall be of 30mesh and have the following materials of construction :Body Fabricated mild steel as per IS:2062 (Tested Quality). Strainer Wires of stainless steel (AISI : 316), 30 SWG, suitably reinforced.
b) Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.
c) Strainers shall be Simplex design.Suitable vent and drain connections with valves shall be provided.
d) Screen open area shall be at least 4 times pipe cross sectional area at inlet.
e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410 M^3/hr flow.

7.03.15 **Y-type On-line Strainer**

Body shall be constructed of mild steel as per IS:2062 (tested quality). Strainer wires shall be of stainless steel AISI:316, 30 SWG, 30 mesh.
Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be atleast 4 times pipe cross-sectional area at inlet.

7.03.16 **Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).**

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.
Materials of construction shall be as follows :

a) Column pipe M.S. IS:1239 med. grade.
b) Hydrant Valve
   i) Body Gun metal.
   ii) Trim Leaded tin bronze as per IS:318, Grade-2.
   iii) Hand Wheel Cast Iron as per IS:210, Grade-20.
   iv) Washer, gasket etc. Rubber as per IS:638.
   v) Quick coupling connection Leaded tin bronze as per S:318, Grade-2.

vi) Spring Phosphor Bronze as per IS:7608.

vii) Cap and chainLeaded tin bronze as per IS:318, Grade-2.The general design of hydrant valve shall conform to IS:5290. 7.03.17

Hoses, Nozzles, Branch pipes and Hose boxes

(a) Hose pipes shall be of unlined flax canvas/reinforced rubber-lined canvas construction as per IS:4927/type A of IS:636 with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere. All hoses shall be ISI marked.

(b) Hosepipes shall be capable of withstanding an internal water pressure of not less than 35 kg/cm^2 without bursting. It must alsowithstand a working pressure of 8.5 kg/cm^2 without undue leakage or sweating.

(c) Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanised mild steel wires and leather bands.

(d) Branch pipes shall be constructed of copper and have rings of leaded tin bronze (as per IS:318 Grade-2) at both ends. One end of the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.

(e) Nozzles shall be constructed of leaded tin bronze as per IS:318, Grade-2.

(f) Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.

(g) Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use. The furnished design must meet the approval of Tariff Advisory Committee.

(h) All instantaneous couplings, as mentioned under clause Nos.3.03.19, 3.03.20 and 3.03.21 above shall be of identical design (both male and female) so that any one can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8kg/cm^2 of water. Designs employing screwing or turning to have engagement shall not be accepted.

7.04.00 **Fabrication** &**Erection**

7.04.01 The contractor shall fabricate all the pipework strictly in accordance with the related approved drawings.

7.04.02 **End Preparation**

(a) For steel pipes, end preparation for butt welding shall be done by machining.

(b) Socket weld end preparation shall be sawing/machining.

(c) For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

7.04.03 **Pipe Joints**

(a) In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.

(b) Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

7.04.04 **Overground Piping**

(a) Piping to be laid overground & inside the trench shall be supported on pipe rack/supports.The trenches shall be of covered type. The trench/Rack/supports details shall have to be approved by Employer/Engineer.There shall be sufficient clearance inside the trench around the pipe to enable easy paint/maintenance work.

(b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red lead primer shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.04.05 **Buried Pipe Lines**

(a) Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively corrosion resistant tapes can also be used for protection of pipes against corrosion.

(b) Coating and wrapping shall be in line with IS:10221.

(c) Buried pipelines shall be laid with the top of pipe one meter below ground level.

(d) At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to indicate any fault hole breaks or conductive particle in the protective coating.

7.05.00 **General Instruction for Piping Design and Construction**

7.05.01 while erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.05.02 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.06.00 **Tests at Works**

7.06.01 **Pipes**

(i) Mechanical and chemical tests shall be performed as required in the codes/standards.

(ii) All pipes shall be subjected to hydrostatic tests as required in the codes/standards.

(iii) 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME VIII.

7.06.02 **Valves**

(i) Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.

(ii) All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

(iii) Air test shall be conducted to detect seat leakage.

(iv) Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.

(v) No repair work on CI valve body, bonnet or wedge shall be allowed.

7.06.03 **Strainers**

(i) Mechanical and chemical tests shall be conducted on materials of the strainer.

(ii) Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm2g whichever is higher for a period of one hour.

(iii) Pressure drop test on one strainer of each size/type shall be conducted.

7.06.04 **Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)**

(i) The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 kg/cm^2g to detect any leakage through defects of casting.

(ii) Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm^2g and the flow through the valve shall not be less than 900 litres/min.

(iii) Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 14 kg/cm^{2}g.

7.06.05 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

Unlined flax/reinforced rubber-lined canvas hoses shall be tested hydrostatically. Following tests shall be included as per IS:4927/IS:636.

a) Percolation test
b) Pressure test at 21 kg/cm^{2}g
c) Burst test at 32 kg/cm^{2}g (minimum)

The branch pipe, coupling and nozzles shall be subjected to a hydrostatictest pressure of 21 kg/cm2g to detect any leakage through defects of casting. Dimensional checks shall be made on the hose boxes and nozzle spanners.

8.00.00 **AIR VESSELS**

8.01.00 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per IS:2825.

8.02.00 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/ linings as required.

8.03.00 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.04.02 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Owner.

8.04.03 Welding procedure and Welder's qualification tests will be carried out as per relevant IS Standard.

8.04.04 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

9.00.00 **HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES**

9.00.01 **Intent of Specification**

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.

9.00.02 **Codes and Standards**

All equipment supplied shall conform to internationally accepted codes and standards. All equipment offered by Bidders should be TAC approved or have been in use in installations which have been approved by TAC.

9.01.00 **Heat Detectors, Quartzoid bulb type.** (Used in HVW spray system)

a) Heat detectors shall be of any approved and tested type. Fusible chemical pellet type heat detectors are however not acceptable.
b) Temperature rating of the heat detector shall be selected by the Bidder taking into consideration the environment in which the detectors shall operate. Minimum set point shall, however, be 79°C.
c) Heat detectors shall be guaranteed to function properly without any maintenance work for a period of not less than twenty five (25) years.
d) The heat detectors must be approved by the Tariff Advisory Committee, India or FOC, London or a reputed international authority.
e) The heat detectors shall be mounted on a pipe network charged with water at suitable pressure. On receipt of heat from fire, the heat detector will release the water pressure from the network. This drop in water pressure will actuate the Deluge valve.
f) The Bidder may offer alternative method of heat detection and type of heat detectors, provided these are acceptable to the Tariff Advisory Committee and the Employer.

9.02.00 **HVW Spray Nozzles (Projectors)**

High velocity water spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity

which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling. Integral non-ferrous strainers shall be provided in the projectors ahead of the orifice to arrest higher size particle, which are not allowed to pass through the projectors. Material of construction of projector shall be in line with TAC/NFPA requirement.

9.03.00 **Fire Detectors**

9.03.01 Fire detectors shall be approved by FOC-London or similar international authorities and also by Tariff Advisory Committee of India.

9.03.02 Both smoke and heat type fire detectors shall be used Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.03.03 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation. The set point shall be adjustable.

9.03.04 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.03.05 Approval from Department of Atomic Energy (DAE), Government of India shall be made available for ionisation type smoke detectors. All accessories required to satisfy DAE shall also be included in the scope of supply.

9.03.06 Fire detectors shall be guaranteed to function properly without any maintenance work for a period of not less than ten (10) years.

10.00.00 **PORTABLE AND WHEEL/ TROLLEY MOUNTED FIRE EXTINGUISHERS**

10.00.01 Intent of Specification

This specification lays down the requirement regarding fire extinguishers of following types :

Portable fire extinguishers.

a) Pressurised water type.
b) Dry chemical powder type
c) Carbon Dioxide type

Wheel/ Trolley mounted fire extinguishers.

a) Dry chemical powder type
b) Carbon Dioxide type

10.00.02 All the extinguishers offered by the Bidder shall be of reputed make and should have been approved by Tariff Advisory Committee of India or any other international authorities like FOC - London/NFPA-USA. Certificates to this effect shall be furnished by the Bidder. All extinguishers shall be ISI marked.

10.01.00 **Design and Construction**

10.01.01 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.

10.01.02 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

10.01.03 All extinguishers shall be supplied with initial charge and accessories as required.

10.01.04 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

10.01.05 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

10.01.06 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. The constant air pressure type shall conform to IS:6234 and the gas pressure type shall conform to IS:940. Both these extinguishers shall be ISI marked.

Dry chemical powder type extinguisher shall conform to IS : 2171. Carbon Dioxide type extinguisher shall conform to IS:2878.

Wheel/ trolley mounted fire extinguishers of Dry chemical powder type shall conform to IS:10658 Wheel/ trolley mounted fire extinguishers of Carbon dioxide type shall conform to IS:2878

Tests and Inspection

Particulars of shop tests and procedure shall be submitted to the Employer before hand for his approval.

A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

10.02.03 Performance testing of extinguisher shall be in line of applicable Indian Standards. In case where no Indian Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

10.03.00 **Performance Guarantee**

The Contractor shall guarantee all equipment supplied by him against any defect due to faulty design, material and workmanship. The equipment shall be guaranteed to operate satisfactorily at the rated conditions at site.

10.04.00 **Painting**

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

11.00.00 **INSTRUMENTS**

11.00.01 **Intent of Specification**

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.00.02 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.01.00 **Local Instruments**

Pressure/Combination/Differential Gauges & Switches.

11.01.01 The pressure sensing elements shall be continuous 'C' bourdon type.

11.01.02 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand atleast twice the full scale pressure/vacuum without any damage or permanent deformation.

11.01.03 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.01.04 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.

11.01.05 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.01.06 Weatherproof type construction shall be provided for all gauges. This type of construction shall be dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to NEMA- 4.

11.01.07 All gauges shall have micrometer type zero adjuster.

11.01.08 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm^2 and above.

11.01.09 Scales shall be concentric, white with black lettering and shall be in metric units.

11.01.10 Accuracy shall be + 1.0 percent of full range or better.

11.01.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading.

All gauges shall have 1/2 inch NPT bottom connection. All instruments shall conform to IS : 3624 - 1966.

All instruments shall be provided with 3 way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.

Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.

11.01.12 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.

11.01.13 Necessary accessories shall be furnished.

11.02.00 **Timers**

11.02.01 The timers shall be electro-mechanical type with adjustable delay on pick-up or reset as required.

11.02.02 Each timer shall have two pairs of contacts in required combination of NO and NC.

11.03.00 **Level Gauges/Indicator/Switches**

11.03.01 **Level Gauges**

i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.

ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.

iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.

iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.

vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.03.02 **Level Indicators**

i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.

ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.

iii) The scale indicator shall be provided at a suitable height for ease of reading.

iv) Accuracy shall be + 1% of scale range or better.

11.03.03 **Level Switches**

i) Level switches shall be of ball float operated magnetic type complete with cage.

ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.

iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within ± 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.04.00 **Solenoid Valves**

11.04.01 The body of the valves shall be Forged brass or stainless steel.

11.04.02 The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.

11.04.03 The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.

11.04.04 The valves shall be suitable for mounting in any position.

11.05.00 **Switches, Lamps, Meters Etc.**

All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.

11.06.00 All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.

11.07.00 Makes of control panel and local instruments, accessories shall be as per Employer's approval.

12.00.00 **ELECTRIC MOTORS**

12.01.00 **General**

12.01.01 This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.

12.02.02 In case of contradiction between this specifications and IS or IEC, the stipulations of this specification shall be treated as applicable.

12.02.03 National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.03.00 **Design Features**

12.03.01 **Rating and type**

(i) The induction motors shall be of squirrel cage type unless specified otherwise.

(ii) The motors shall be suitable for continuous duty in the specified ambient temperature.

(iii) The MCR KW rating of the motors for 50°C ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

(iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars :

a) Rated terminal voltage From 0.2 to 200 KW Below 0.2 KW Variation in voltage ± 6%.	415V (3 Phase, solidly earthed) 240 V (1Phase, solidly earthed)
b) Frequency	50 Hz ± 3%.
c) Any combination of (a) & (b)	

Motors to be installed outdoor and semi-outdoor shall have hose proof enclosure equivalent to IP-55 as per IS : 4691. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54 as per IS : 4691. For hazardous locations, the enclosures of the motor shall be of flameproof construction.

12.03.02 **Cooling method**

Motors shall be TEFC (totally enclosed fan cooled type.

12.03.03 **Enclosure**

12.03.04 **Starting requirements**

(i) **Induction motor**

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 electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IS : 325.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.03.01 (iv) (a) shall be capable of withstanding atleast two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.03.04 (i) (a) 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 speeds 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.

12.03.05 **Running requirements**

(i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise over the ambient temperature of 50°C shall be within the limits specified in IS : 325 (for 3-phase induction motors) and IS : 996 (for 1 phase motor) after adjustment due to increase ambient temperature specified herein.

(ii) 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.

(iii) 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.

(iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.

(v) Motors shall be capable of developing the rated full load torque even when the

supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.

(vi) The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

(viii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.04.00 **Construction Features**

12.04.01 **Stator**

(i) Stator frame

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

(ii) Stator core

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

(iii) Insulation and winding

a) All insulated winding conductor shall be of copper. The overall motor winding insulation for all 415 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 50°C.

12.04.02 **Rotor**

(ii) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.

(iii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

12.04.03 **Terminal box leads**

(i) For motors of 415 Volts and below a single terminal box may be provided for power and accessories leads.

(ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

(iii) Terminal box shall be suitable for top and bottom entry of cables.

(iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360° in steps in 90°.

(v) The terminals shall be complete with all accessories for connectingexternal cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.

(vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.

(vii) Terminal box for single core cable shall be of non- magnetic material.

(viii) Marking of all terminals shall be in accordance with IS : 4728.

12.04.04 **Rating Plates**

(i) Rating plates shall be provided for all motors giving the details as called for in the following standards.

a) IS : 325 (for three phase squirrel cage induction motors).

b) IS : 996 (for single phase A.C. and universal electric motors).

(ii) In addition to above, the rating plate shall indicate the following :

a) Temperature rise in °C under normal working conditions.

b) Phase sequence corresponding to the direction of rotation for the application.

c) Bearing identification number (in case of ball/ roller bearing) and recommended lubricants.

12.04.05 **Other Constructional Features**

(i) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.

(ii) Motor weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.05.00 **Paint and Finish**

12.05.01 Motor external parts shall be fmished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.05.02 Motor fans shall also be painted to withstand corrosion.

12.05.03 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.05.04 Current carrying fasteners shall be either of stainless steel or high tensile brass.

12.06.00 **Tests at Manufacturers Works**

12.06.01 Motors shall be subject to routine tests in accordance with the following standards

a) For 3 phase induction motors IS : 325 & IS : 4029

b) For single phase induction motors IS : 996

12.06.02 In addition, the following tests shall also be carried out :

a) 20% over speed test for 2 minutes on all rotors.

b) Measurement of vibration.

c) Measurement of noise level.

d) Phase sequence and polarity checks relative to mechanical rotation.

12.06.03 Results of routine tests carried out on all motors in accordance with the standards indicated above shall be furnished to the Engineer in six (6) copies for his scrutiny and approval. Only on acceptance from his side, motors can be considered suitable for despatch.

12.06.04 The Employer reserves the right to send his representative(s) to witness the tests. At least 3 weeks notice shall be given intimating the date of tests.

TECHNICAL DATA SHEETS FOR FIRE FIGHTING EQUIPMENT

DATA SHEET FOR DELUGE VALVE		
1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Number & size	As per approved system drawings.
3.0	Type	Differential Diaphragm type.
4.0	Rating	
4.1	Flow in M^3/hr. 1.150 mm 2.100 mm	 170 to 650 50 to 225
4.2	Pressure	Working Pressure -12.3 kg/cm^2 Test Pressure -25 kg/ cm^2.
4.3	Pressure drop in equivalent length 1.150 mm 2. 100 mm	19 M 11 M
5.0	**Material of construction**	
5.1	Body	CI IS :210 Gr.FG 260
5.2	Valve internal	Cast Bronze- IS:318-LTB 2
5.3	Seat Seal	Neoprene Rubber
5.4	Diaphragm	Neoprene Rubber
6.0	Differential pressure required for operation	Differential Ratio-50 %
7.0	Water Motor Gong provided	Yes
7.1	Type	Hydraulic type
7.2	**Material of Construction** :	
7.2.1	Housing	Al. Alloy-IS :617
7.2.2	Cover/Rotor./Gong	Aluminium to IS :737
7.2.3	Manual actuation lever provided?	Yes
8.0	Remote actuation with Solenoid Valve provided?	Yes
9.0	Resetting type	Manual resetting type
10.0	Deluge valve complete with test and drain valves, manual operation arrangement, supporting structures and all necessary accessories.	Yes
11.0	Approval of Deluge Valve.	FM of USA,UL of USA,LPCB of U.K. or VDS of Germany

DATASHEET FOR HVW SPRAY NOZZLE

1.0	Make	CSPTCL Raipur Approved make
2.0	Type	High velocity water spray type
3.0	Working pressure	3.5 bar to 5 bar
4.0	Material	Brass
5.0	K factor	As per approved design & drawings
6.0	Quantity	As per approved design &

		drawings
7.0	Integral non-ferrous strainer provide	Yes
8.0	Approval of HVW spray Nozzle.	FM of USA,UL of USA, LPCB of U.K. or VDS of Germany

DATA SHEET FOR QUARTZOID BULB DETECTORS

1.0	Make	CSPTCL Raipur Approved make
2.0	Type	Quartzoid bulb type
3.0	Rated pressure	12.3 kg/cm² (175 PSI).
4.0	Hydrotest pressure	30kg/cm²
5.0	Material of construction	
5.1	Frame	Bronze
5.2	Bulb	Glass
5.3	Deflector	Copper
6.0	Temperature rating	79ºC
7.0	Quantity	As per approved drawings
8.0	Approval of Detector	FM of USA, UL of USA,LPCB of U.K. or VDS of Gemrany

DATA SHEET FOR OPTICAL SMOKE DETECTORS

1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Principle of operation	Light scattering by smoke particles.
3.0	Max. recommended spacing	9 m.
4.0	Normal Operating temperature	-10 ºC to 60ºC
5.0	Guaranteed to function properly without any maintenances work for a period of not less than ten (10) years	Yes. Accumulated dust to be removed periodically by blowing air.
6.0	Approval of detector	FM of USA,UL of USA,LPCB of U.K. or VDS of Germany
7.0	Cabling.	2C X 1.5 sq.mm. un-armoured PVC insulated FR cables conforming to IS 1554(part 1).

DATA SHEET FOR HEAT DETECTORS

1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Principle of operation	Rate of rise-cum-fixed temperature type..
3.0	Set point of operation	5ºC per minute/55ºC

4.0	Max. recommended spacing	6m.
5.0	Normal Operating temperature	-20 ºC to 70.ºC
6.0	Guaranteed to function properly without any maintenances work for a period of not less than ten (10) years	Yes. Accumulated dust to be removed periodically by blowing air.
7.0	Approval of detector	FM of USA,UL of USA,LPCB of U.K. or VDS of Germany
8.0	Cabling.	2C X 1.5 sq.mm. un-armoured PVC insulated FR cables conforming to IS 1554(part 1).

DATA SHEET FOR IONISATION SMOKE DETECTORS

1.0	Manufacturer	CSPTCL Raipur Approved make
3.0	Principle of operation	Ionisation of air by Radio-active source.
4.0	Radio-active source	Americium -241
5.0	Max. recommended spacing	9 m.
6.0	Normal Operating temperature	-10ºC to 60ºC
8.0	Guaranteed to function properly without any maintenances work for a period of not less than ten (10) years	Yes. Accumulated dust to be removed periodically by blowing air.
9.0	Approval of detector	FM of USA,UL of USA,LPCB of U.K. or VDS of Germany
10.0	Cabling.	2C X 1.5 sq.mm. un-armoured PVC insulated FR cables conforming to IS 1554(part 1).

DATA SHEET FOR 2C x 2.5sq.mm Armoured cable

1.0	Make	CSPTCL Raipur Approved make
2.0	Type	Control Cable
3.0	Number of Cores	Two (2)
4.0	Size	2.5 sq. mm.
4.1	Voltage Grade	1.1 KV
4.2	Applicable standard	IS:1554 Part 1
4.3	Conductor Material	Plain annealed electrolytic copper
5.0	ConductorConstruction	Stranded
5.1	Conductor resistance	12.1 Ohms/ KM at 20ºC
5.2	Insulation material	PVC insulation Type A as per IS:5831
5.3	Insulation thickness	0.8mm Nominal
5.4	Identification	Red & Black
6.0	Inner sheath material	PVC compound Type ST1

		as IS: 5831,FR.
7.0	Inner sheath thickness	0.3mm Minimum
7.1	Outer sheath material	PVC compound Type ST2 as per IS:5381,FR.
7.2	Outer sheath thickness	1.8 mm Nominal.
7.2.1	Outer sheath colour	Grey
7.2.2	Overall Diameter	As per manufacturer design data

DATA SHEET FOR MANUAL CALL POINT		
1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Construction	Deep drawn sheet steel
3.0	Type	Break glass with push button.
4.0	Operating Voltage	24 V DC 10%
5.0	Type of control	Pole –NO/NC
6.0	Degree of protection	IP 52
7.0	Material of housing	M.S. 18 Gauge
8.0	Colour	FIRE RED
9.0	Accessories	Hammer & Chain assembly
DATA SHEET FOR FIRE ALARM SOUNDER (HOOTER)		
1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Construction	Deep drawn sheet steel
3.0	Type	Dual tone/Single tone
4.0	Operating Voltage	24 V DC ± 10%
5.0	Output	Not less than 80Db(A) but not more than 120 Db (A)at 1.5m distance
6.0	Output frequency range	500 Hz. To 1000 Hz.
7.0	Operating time	50 minutes (Minimum)
8.0	Material of housing	M.S. 18 Gauge
9.0	Colour	FIRE RED
10.0	Marking	FIRE ALARM.

DATA SHEET FOR GLOBE VALVE		
1.0	Nominal size in mm.	15 TO 40
2.0	Make	CSPTCL Raipur Approved make
3.0	Type	Globe
4.0	Number	As per approved system drawings.
5.0	**Material of construction**	
5.1	Body	Bronze to IS 318 Grade LTB2
5.2	Hand wheel	Grey cast iron. grade FG200 of IS 210.
5.3	Bonnet & Bonnet Wedge	Bronze to IS 318 Grade LTB2
5.4	Trim	Bronze to IS 318 Grade LTB2
6.0	End connection	Screwed
7.0	Standard	IS:778

8.0	Rating	PN 1.6
9.0	Hydrostatic test pressure	
9.1	Body	24 kg/cm²
9.2	Seat	16 kg/cm²

DATA SHEET FOR GUN METAL GATE/SLUICE VALVE			
1.0	Nominal size in mm.	15 TO 40	50 to 300
2.0	Make	CSPTCL Raipur Approved make	
3.0	Type	Gate /Sluice	
4.0	Number	As per approved system drawings.	
5.0	**Material of construction**		
5.1	Body	Bronze to IS 318 Grade LTB2	Grey cast iron. grade FG200 of IS 210
5.2	Hand wheel	Grey cast iron. Grade FG200 of IS 210.	
5.3	Bonnet & Wedge	Bronze to IS 318 Grade LTB2	Grey cast iron, grade FG200 of IS 210.
5.4	Stem	High tensile brass,Grade HT or HT 2of IS: 320	Stainless steel
6.0	End connection	Screwed	Flanged
7.0	Standard	IS:778	IS:14846
8.0	Rating	PN 1.6	
9.0	Hydrostatic test pressure		
9.1	Body	24 kg/cm²	
9.2	Seat	16 kg/cm²	

DATA SHEET FOR FLOAT OPERATED VALVE		
1.0	Manufacturer	CSPTCL Raipur Approved make
2.0	Type	Float operated valve
3.0	Size	100 MM
4.0	Quantity	2Nos.
5.0	Material of construction	
5.1	Body	Cast Iron(IS:210 FG:200)
5.2	Seat Ring	Gun Metal(IS:318,LTB-2)
5.3	Disc Ring	Gun Metal(IS:318,LTB-2)
5.4	Spindle	13% Cr. Stainless steel
5.5	Piston	Cast Iron(IS:210,FG:200)
5.6	Lever	Mild Steel(IS:226)
5.7	Float	Tin Coated Copper
5.8	Fulcrum	Mild Steel (IS:226)
5.9	Pilot Valve	Stainless Steel (AISI-304)
5.10	Gland Packing	Graphited Asbestos Rope
5.11	Bonnet	Cast Iron (IS:210,FG:200)
6.0	Hydrostatic test pressure	
6.1	Body	15kg/cm²
6.2	Seat	10 kg/cm²
7.0	End connection	Flanged connection

DATA SHEET FOR CHECK VALVES (NON –RETURN VALVES)		
1.0.0	Make	CSPTCL Raipur Approved make
1.1.0	Type	Swing Check Type
1.2.0	Standard followed	IS:5312
1.3.0	Rating	PN 1.6
1.4.0	Material of construction, Dimensions.	As per IS:5312
1.5.0	Inlet Outlet details	Flanged
1.6.0	Hydrostatic test pressure ,kg/cm²	
1.6.1	Body	24
1.6.2	Seat	16

13.00.00 **BATTERY &BATTERY CHARGERS FOR DIESEL ENGINE**

This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps.

13.01.00 **General Information**

13.01.01 The equipment specified hereinafter are required for starting the dieselengines and other operation of the plant as required.

13.01.02 For each diesel engine there shall be two (2) sets of Battery and two (2) setsof Battery Charger.

13.01.03 The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements :

13.01.04 Float charging the Battery.

13.01.05 Boost Charging the Battery.

13.01.06 The battery shall be large enough to crank the engine 10 times without charging in between and without getting drained to an extent which will affect its life.

13.01.07 The Bidder shall indicate the battery voltage and battery capacity in Ampere- Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage required for operation of the D.C. loads.

13.02.00 **General Design**

The Battery and Battery Charger shall be located indoor

The Battery Charger shall have suitable provision for mounting on column/wall.

13.02.01 **Battery**

(i) The cells shall be lead-acid type. The Battery shall be automotivetype.

(ii) The cells shall be sealed in type with anti-splash type vent plug.

(iii) The cell terminal posts shall be provided with connector bolts andnuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

(iv) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.

(v) The electrolyte shall be of battery grade Sulphuric Acid conforming to IS : 226-2962. Water for storage batteries conforming to IS : 1069 shall be used in the preparation of the electrolyte.

13.02.02 **Battery Charger**

(i) The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for

trouble free operation. All devices and equipment shall conform to relevant Indian Standard or shall be Superior to it.

(ii) The scheme of the battery charger shall be such that the battery can be charged automatically as well as manually.

(iii) The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

(iv) The charging equipment shall be housed in a panel of sheet steel construction with hinged door on the front side. The minimum thickness of sheet steel shall be 2.5 mm. The panel shall have suitable provision for taking the cable from bottom/top.

(v) The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.

(vi) The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.

(vii) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.

(viii) The panel shall be chemically cleaned, rinsed, bonderised, rinsed and air dried. Immediately after bonderising, the steel shall be sprayed with a coat of primer. The finish of the panel shall consist of two coats of sprayed-on pearl grey enamel or lacquers (IS:631).

13.03.00 **Testing**

13.03.01 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IS - 4540

13.03.02 Insulation test.

13.03.03 Connection checking.

13.03.04 Measurement of voltage regulation.

13.03.05 Auxiliary of devices.

13.03.06 Alternating current measurement.

13.03.07 Performance test.

13.03.08 Temperature rise test.

13.03.09 Following acceptance tests shall be carried out in batteries as per IS : 1651.

a) Marking and packing
b) Verification of dimensions
c) Test for capacity
d) Test for voltage during discharge

14.00.00 CONTROL & ANNUNCIATION PANELS

14.01.00 **Intent of Specification**

The following requirement shall be applicable to the control and annunciation panels furnished under these specifications.

14.02.00 **General Information**

14.02.01 The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.

14.02.02 The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected to approval by the Employer.

14.02.03 The reference ambient temperature outside the panel shall be taken as 50°Cand relative humidity 100%.

14.03.00 **Equipment to be Furnished**

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant. Details are included in sub-section General.

14.04.00 **Constructional Details**

14.04.01 The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

14.04.02 Free standing type panels shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall have a degree of protection of IP:52 as per IS:2147.

14.04.03 If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

14.04.04 Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

14.04.05 The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. If the control panel height is small then it should be mounted on a separate support so that the operating height of the equipment comes within the above limit. The proper supporting arrangement shall be provided by the Contractor.

14.04.06 Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

14.04.07 All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal and adjustment are readily accessible for inspection or maintenance and their removal and replacement can be done without interruption of service to other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

14.05.00 **Name Plates and Labels**

14.05.01 Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

14.05.02 All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

14.05.03 Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

14.06.00 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT

circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

14.07.00 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.07.01 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

14.08.00 **Terminal Blocks**

14.08.01 Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one-piece moulding. It shall be complete with insulating barriers, stud typeterminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

14.08.02 Terminal blocks shall be arranged with at least 100 mm clearance betweentwo sets of terminal block.

14.08.03 The terminal blocks shall have at least 20% spare terminals.

14.09.00 **Grounding**

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10.00 **Space Heater and Lighting**

14.10.01 Space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.10.02 The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

14.10.03 Free standing panel shall have a 240V AC, plug point and a fluorescent lightoperated by door switch.

14.11.00 **Control and Selector Switches**

14.11.01 Control and selector switches shall be of rotary type, with escutcheon platesclearly marked to show the function and positions.

14.11.02 Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

14.11.03 The contact ratings shall be at least the following :

i) Make and carry continuously 10 Amp.
ii) Breaking current at 240V DC lAmp. (Inductive)
iii) Breaking current at 240V DC 5 Amp. at 0.3 p.f. lagging

14.12.00 **Push Buttons**

14.12.01 Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 240V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

14.12.02 All push buttons shall be provided with integral escutcheon plates markedwith its function.

14.12.03 The colour of buttons shall be as follows :

Green For motor START, Breaker CLOSE, Valve/ damper OPEN.
Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.
Black For all annunciation functions, overload reset andmiscellaneous.

14.12.04 Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13.00 **Indicating Lamps**

14.13.01 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption. Lamps shall be provided with series resistors preferably built-in- the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.13.02 Lamp shall have translucent lamp covers of the following colours :

Red for motor OFF, Valve/damper OPEN, Breaker CLOSED.
Green for motor ON, Valve/damper CLOSED, Breaker OPEN.
White for motor AUTO-TRIP.
Blue for all healthy conditions (e.g. control supply, lub oilpressure and also for spring charged).
Amber for all ALARM conditions (e.g. pressure low, over load andalso for 'service' and 'Test' position indication).

14.13.03 Bulbs and lamps covers shall be easily replaceable from the front of thepanel.

14.13.04 Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normallybe located above the red and green lamps.

14.14.00 **Fuses**

14.14.01 All fuses shall be of HRC cartridge plug-in-type and shall be of suitablerating, depending upon circuit requirements.

14.14.02 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15.00 **Contactors**

14.15.01 Contactors shall be of air break, electromagnetic type rated as per requirement. These shall be of utilisation category AC 3 as per IS:2959.

14.15.02 Operating coils of AC contactors shall be of 240V AC or 220V DC as required. AC contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall not drop out at 70% of the rated voltage.

14.15.03 DC contactors shall have a coil voltage of 220V DC and shall be suitablefor satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16.00 **Relays and Timers**

14.16.01 All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.

14.16.02 All relays and timers shall have at least two NO and two NC contacts.

14.16.03 All relays and timers shall be suitable for 240V AC and 220V DC as required. DC relays shall operate satisfactorily between 70% to 110% and AC relays shall be suitable for voltage variation between 80% to 110%.

14.17.00 **Indication Instruments**

14.17.01 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

14.17.02 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.

14.17.03 All instruments shall have white dials with black numerals and lettering.Black knife edge pointer with parallax free dials will be preferred.

14.17.04 Ammeters provided on motor feeders shall have a compressed scale at theupper current region to cover the starting current.

14.18.00 **Annunciation System**

14.18.01 The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.

14.18.02 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black letters on white background). Each window shall be provided with two lamps.

14.18.03 Audible horn shall sound when a trouble contact operates and shall continueto sound until the acknowledge button is pressed.

14.18.04 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

14.18.05 After acknowledge button is pressed, the horn and flashing shall stop but the indication lamp shall remain lighted.

14.18.06 After trouble is cleared indication lamps shall be ready and shall go off onlywhen reset.

14.18.07 Silencing the horn in conjunction with one trouble contact shall not stop andhorn sounding if another trouble contact operates.

14.18.08 When test button is pressed, all lamps shall flash and horn shall sound.

14.18.09 Annunciator systems shall operate on 220V DC Systems.

14.18.10 The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.

14.18.11 List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.

14.18.12 20% spare windows shall be provided on the panel.

14.19.01 All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005, Degreasing shall be done by alkaline cleaning. Dust and scale shall be removed by pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Electrostatic painting shall also be acceptable. Finishing paint on panels shall be shade 692 (smoke grey) of IS:5 unless required otherwise by the Employer. The inside of the panels shall be glossy white. Each coat of finishing shall be properly stoved. The paint thickness shall not be less than 50 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.

14.20.00 **Tests**

14.20.01 Following tests/inspection shall be carried out by the Contractor in thepresence of Employer's representative :

(A) Factory Tests

1. Compliance with approved drawings, data and specification.
2. Visual check for workmanship.
3. Wiring continuity and functional checks.
4. Calibration of instruments, relays and metres wherever required by inspector.
5. HV test

6. Insulation resistance measurement before and after HV test.
7. Testing to observe compliance to degree of protection as per IS -2147 (latest).

(B) Inspection/Testing at site :

1. IR test before and after HV test
2. HV Test
3. Functional Testing.

(C)

1. The Fire detection and annunciation panel shall be Tested as per BS:3116 Part-W.
2. The Annunciation System shall be routine tested

Connection from Battery terminals:- The positive & negative connection from the battery to the charger and the DC distribution shall be through separate copper cables. Aluminium cables shall not be accepted. In view of the failure of insulation and consequent shorting of positive & negative wires in the same cable, it is clearly specified that the positive & negative cables shall be entirely separate

STATION TRANSFORMER

1.0 **INTENT**

This specification is intended to cover outdoor type oil filled 33/0.415KV, 500KVA Transformers .**The insulation levels of HV windings, HV bushings and clearances shall be suitable for 72.5 KV class**.

2.0 **Scope of Work**

2.1 **Scope of Supply**

Transformers as listed above, with insulating oil, all materials and accessories, and complete in all respects.Gland plates, power cable, lugs, anchor bolts and hardware. Mandatory & optional spares and special maintenance equipments if any.

Scope of Service

The scope includes but is not limited to the following items of work to be performed for all equipment and materials furnished under this section:

a) Design, manufacturing, shop testing, packing & despatch
b) Transportation inclusive of insurance and delivery, FOR site basis
c) Unloading, handling, storing, transportation at site upto foundations, oil filling and treatment, erection, testing and commissioning
d) Civil Works
e) Supply of external cables and termination as required.
f) Fire protection system.

3.0 **General Information**

3.1 All temperature indicators, Buchholz relays and other auxiliary devices shall be suitable for 220 V DC Control supply. All alarm and trip Contacts shall also be suitable for connection in 220V DC Circuits.

3.2 Bidders may specifically note that Purchaser proposes to insist on short circuit test as per Clause 16.11 of IS:2026 (Part-I)-1977 and dielectric test as per IS-2026. Any deviation in this regard shall be sufficient ground for rejection of the bid.

4.0 **TECHNICAL REQUIREMENTS**

4.1 **Core**

The core shall be constructed from high grade, nonaging, cold rolled grain-oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10% voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

4.2 **Windings**

The conductor shall be of electrolytic copper, free from Scalesand burrs.

4.3 **Insulating Oil**

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IS:335 while tested at oil Contractor's premises, No inhibitors shall be used in oil. Ten percent extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

4.4 **Terminal Arrangement**

a) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable/overhead conductors termination of HV side and cable termination on LV side.
b) The neutral terminals of 415V winding shall be brought out on a bushing along with the 415 volt phase terminals to form a 4 wire system for the 415 volt. Additional neutral bushing shall also be provided for earthing.

4.5 **Off Circuit Tap Changing Equipment**

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

4.6 **Marshalling Box**

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IS: 2147

4.7 **Cable boxes**

Whenever cable connections are required, suitable cable boxes shall be provided and shall be air insulated. They shall be of sufficient size to accommodate Purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

5.0 **Inspection and Testing**

a) The Contractor shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The programme shall be duly approved by the Purchaser.

b) The Contractor shall carryout all type tests and routine tests on the transformers as per relevant standards. Type tests shall be carried out on one transformer of each type and routine tests shall be carried out on all transformers. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

6.0 Inspection

6.1 **Tank and Accessories**

a) Physical and dimensional check of transformer tank and accessories.

b) Crack detection of major strength weld seams by dye penetration test.

6.2 **Core**

a) Physical inspection and check of quality of varnish, if used.

b) Sample testing of core material for checking specific loss, bend properties, magnestisation, characteristics and thickness.

c) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.

d) HV Test

6.3 **Insulating Material**

a) Sample checks for physical properties of the material

b) Check for dielectric strength

c) Check for the reaction of hot oil on insulating material

6.4 **Winding**

a) Sample check on winding conductor for mechanical properties and electrical conductivity and on installation covering.

b) Sample check on insulation paper for pH value, Bursting strength, Electric strength.

6.5 **Assembled Transformer**

a) Check complete transformer against approved outline drawing provision for all fittings, finish etc.

b) Jacking test on all the assembled transformers.

6.6 **Oil**

All standard tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Purchaser for approval. Such programme shall include the following components:

a) Buchholz Relay
b) Winding temperature Indicator
c) Bushings
d) Marshalling Box
e) Tap changer switch
f) Oil temperature indicator

7.0 **Factory Test**

7.1 All standard routine tests in accordance with latest issue of IS : 2026 shall be carried out oneach transformer.

7.2 All the type tests in accordance with latest issues of IS : 2026 shall be conducted ononetransformer of each rating.

7.3 In addition to all type and routine tests, following additional type tests shall also be carriedout on one transformer of each rating as per IS : 2026.

a) Measurement of zero sequence impedance
b) Short circuit test
c) Measurement of acoustic noise level. This shall conform to NEMA standard publication
d) Measurement of capacitance and tan delta of transformer winding.
e) Test on oil samples.
Sequence of testing shall be mutually agreed between Purchaser and Contractor after award.

7.4 All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall besubmitted for bought out items.

7.5 High voltage withstand test shall be performed on auxiliary equipment and wiring aftercomplete assembly.

7.6 Tank Tests:

a) Routine Tests: As per CBIP Manual on Transformers
b) Type Tests:
i) Vacuum Tests: As per CBIP Manual on Transformers
ii) Pressure Test: As per CBIP Manual on Transformers

7.7 In addition to the above, the following checks should be carried out at manufacturer's worksbefore despatch for all transformers:

a) Check for interchange ability of components of similar transformers and for mounting dimensions.
b) Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, Buchholz relay, conservator etc.
c) Check for proper provision of bracings to arrest the movements of core and winding assembly inside the tank.
d) Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.

7.8 The Contractor shall submit a detailed inspection and testing programme for field activities,covering areas right from the receipt of material stage upto commissioning stage as per IS :1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.

a) Physical checks on each transformer on receipt at site for any damage or short supply.
b) Tests on oil samples
c) Oil leakage test

d) Physical checks for colour of silica in breather
e) Check for oil level in breather housing, conservator tank, etc.
f) Check for correct operation of all protections and alarms.
g) Insulation Resistance Measurement for Main Winding, control wiring etc.
h) Continuously observe the transformer operation at no load for 24 hours.

8.0 Fittings

The following fittings shall be provided with each transformer covered under this specification.

i) Conservator with drain plug and oil filling hole with blanking plate
ii) Plain oil Gauge
iii) Silica gel Breather
iv) Pressure Relief vent
v) Pocket on tank cover for Thermometer
vi) Valves
vii) Earthing Terminals
viii) Rating & Terminal Marking Plates
ix) Lifting Lugs
x) Rollers
xi) Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

9.0 **Spare Parts**

9.1 The list of spares for outdoor type transformers covered under this section shall be asspecified in Section-Project

9.2 In addition, the Bidder shall also recommend optional spare parts and maintenance equipment necessary for three(3) years of successful operation of the equipment. The prices of these shall be indicated in respective schedules and these shall not be considered for the purpose of evaluation.

10.0 **Technical Parameters:The insulation levels of HV windings, HV bushings and clearances shall be suitable for 72.5 KV class.**

S.No	Particulars	Specification
1	Reference of standards	IS 2026/IEC 176
2	Rating	500 KVA
3	Type of winding	Copper wound
4	Service	Outdoor
5	Rated voltage in KV	
	HV Winding	33
	LV Winding	0.415
6	Rated frequency (Hz.)	50
7	Number of phases	3
8	Rated current.	
	H.V	8.75 A
	L.V.	696 A
9	Connection	Dyn 11
10	Type of cooling	ONAN
11	Tap changing equipment	
	Manufacturer	Paragon or equivalent
	LV Variation	+5% to – 5%
	Type	Off circuit bridging
	No. of steps	4 steps, 5 position

S.No	Particulars	Specification
12	Guaranteed positive sequence impedance at 75 Deg. C with 100% rating at principal tap	5% tolerance + 10%
13	Temperature rise over an ambient of 50 deg. C	
	Top oil	40 deg. C
	Winding (by resistance method)	45 deg. C
14	Guaranteed losses at rated voltage (excluding cooler loss) on principal tap and at rated frequency	
	No load loss	1200W
	Load loss	4800W
	Total loss	6000W
15	Cooler data (Type of cooler)	Pressed steel radiator
16	Withstand time for three phase short circuit at terminals(seconds). NOTE: The transformer is protected by means of DO fuses as such the fault clearance is not rapid. The transformer must be designed with proper supports for LV and HV windings with pre-compressed board/permali wood/filling with resin so as to make the winding immovable	3.0 sec. (Three point zero seconds) supplier must confirm this point
17	No load current at rated voltage and rated frequency Amp.	Less than 2% of full load current
18	Insulation level	
	Separate source power frequency voltage withstand	
	HV Winding(KVrms)	140
	LV Winding(KVrms)	2
	Induced over voltage withstand	
	HV Winding(KVrms)	66
	LV Winding(KVrms)	0.83
	Full wave lightning impulse withstand	
	HV Winding(KVp)	325 KV
	LV Winding(KVp)	--
19	Regulation at full load at 75 deg. C	
	At unit power factor (%)	Please furnish
	At 0.80 power factor (%)	Please furnish
20	Over excitation withstand timer (seconds)	
	120%	1 minute
	150%	3 seconds
21	Proposed method of transformer shipment	By road transport
22	Total quantity of oil	Please furnish
23	Efficiency at 75 deg. C	Please furnish
	At full load (%)	
	At ¼ full load	
	At ½ full load	

S.No	Particulars	Specification
24	Approximate dimensions	Please furnish
	Tank enclosure(minimum) Note:- The size of tank shall be so decided that a minimum clearance of 75mm is available at every point between live parts and tank. Minimum phase to phase clearance at outer diameter of R&Y, Y&B. HT coils shall be 40mm. This shall be specifically checked at the time of inspection.	
25	Undertaking height	Please furnish
	Approximate weight	Please furnish
	Core & winding (Kg)	
	Tank fittings(kg)	
	Oil (Kg)	
	Total weight (Kg)	Please furnish
26	P.R.V.: The transformer shall be fitted with Pressure Relief Device which will operate at 5 PSI and reset at 1 PSI in addition to explosion vent	Please confirm
27	Tank plate gauge	
	Top & Bottom	Minimum 5mm
	Side plates (with stiffeners)	Minimum 3.5 mm
28	Top of the tank	Slanted to avoid collection of rain water
29	Oil parameters	EHV grade-I as per ISS 335
30	Bushing characteristics HV-72.5 KV	Dry withstand: 140 KV Wet withstand: 140 KV Impulse withstand: 325 KV
31	Material used in Bushing rod	Brass
32	Size of bushing rod	HV 30mm LV 30mm
33	Details of provision for shrinkage of winding	Pre shrinking will be done before final essentially during process
34	Type of transformer tank	Rectangular
35	Arrangement of clamping of winding ends to bushing terminals	Brazing, through multi paper covered leads
36	Bucholz relay	Please confirm

STATION BATTERY & BATTERY CHARGER

1. GENERAL TECHNICAL REQUIREMENTS

1.1. A new set of 220 V/48 V batteries, battery chargers and DCDB shall be supplied,erected and commissioned in new control room building by the bidder to cater the entire DC load of 400/220/132 KV S/s Dhardehi. The new DC supply shall be extended as source to existing DCDB of 220 S/s Dhardehi. The existing DC batteries shall be dismantled on commissioning of the new set supplied.

All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.2. **For 400 / 220 kV sub-station :**

Lead Acid Battery shall be of conventional type cells shall be supplied in transparent Styrene Acrylo Nitrile (SAN) polymer container boxes (with Lid of opaque SAN) and ample space must be provided below the plate for accumulation of deposit. Spray arrestors shall be provided to prevent loss of acid by spraying during charge. The imported design of tubular type batteries may be offered. The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections. The intercell connector shall be of insulated type.

1.3 The 220 V DC System shall consist of two sets of float cum Boost Chargers of 60 Amps capacity with two sets of 600 AH batteries. Each battery charger shall have a standby float cum-boost chargers in addition to main float cum boost battery charger having same capacity.

The 48 V DC System shall consist of two sets of float cum Boost Chargers of 60 Amps capacity with two sets of 600 AH batteries. Each battery charger shall have a standby float cum-boost chargers in addition to main float cum boost battery charger having same capacity.

Bidder shall ensure following system requirement:

System Voltage	Maximum Voltage during Float operation	Minimum voltage available when no charger working and battery fully discharged upto 1.85V per cell.	Nos of cell
220 Volt	242 Volt	203.5 Volt	110
48 Volt	52.8 Volt	44.4 Volt	24

Load type and Duration are given as below:

	Load	**Duration**	**Type Of Loads**
220V D C System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)
48V DC System	Continuous Load	3 hours	Continuous load associated with PLCs.(when speech is not working)
	Momentary Load	15 minute	Loads associated with PLCs (when speech is working)

1.2. Battery

1.2.1. Type

The DC Batteries shall be **Lead-Acid** type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. The 220 V DC system is unearth and 48 V DC system is + ve earth system.

1.2.2. Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

1.2.3. Containers

The container material shall be supplied in transparent Styrene Acrylo Nitrile (SAN) polymer container boxes (with Lid of opaque SAN) and shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except through air vent with a vapour trap. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling.

1.2.4. Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.2.5. Separators

The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6. Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.2.8. Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9. Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10. Battery Bank Stand

All batteries shall be mounted in a suitable single tier wooden stand of teak wood at a convenient height for maintenance. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11. Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27° Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

Loss in capacity during storage at an average ambient temperature of 35° Celcius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12. Expected Battery Life

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

1.2.13. Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

a) Torque wrench. Two nos
b) Digital Multimeter with least count of of voltage measurement - 0.01 V
c) Thermometr two nos
d) Hydrometer four nos
e) Rubber syringe
f) One set bridging connector
g) Rubber Hand gloves Four nos
h) Two copies of printed Instruction sheet
i) One pair of spanner
j) PVC sheet stand Insulators
k) Two no acid resisting funnel and jug each

1.2.14. Type Test of Battery

Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. Tests shall be conducted in accordance with IEC 60896-2 1 & IEC 60896-22, 2004 The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

1.2.15. Installation and commissioning

1.2.15. Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

1.2.16. Contractor shall be submitted following documents for approval:

a) Data sheet
b) GA of cell and layout drawing
c) Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.
d) Temperature correction factors
e) Installation and commissioning Instructions
f) O & M Manual

1.2.17 The cells on which acceptance tests are carried out shall not be supplied.

1.2.18 The cells shall be accommodated in single tier stands constructed of selected timber and painted with 3 coats of acid proof paint. Necessary paint for this purpose shall be supplied no metal fastening shall be used. The stands shall be supported on insulators to obtain necessary insulation from earth and there shall be insulators between each cell and stand. The price of stand shall be included in the cost of the battery. The following accessories shall be supplied along with batteries and prices for the same shall be quoted separately:

1	One Battery Log Book
2	Four Copies Of Printed Instruction Sheet
3	2 No. Cell Testing digital Voltmeter complete with Leads
4	2 No. Rubber Syringe
5	2 No. of Syringe type Hydro Meter suitable for Specific Gravity Reading.
6	2 No. Thermometer (0- 100 Deg C) With Specific Gravity Scale
7	1 Set of Bridging Connector
8	Anti Sulphuric acid Enamel Paint a) Red Colour In Required Quantity b) Black Colour 2 Litres
9	Battery Stand suitable for accommodating the Cells coated with 3 Coats of anti acid paint.
10	Hard Rubber Cells Insulators in required quantity with 4 No.extra (Spare)
11	P.V.C. Sheet Stand Insulators in required quantity with 4 No.extra (Spare)
12	1 Set of Cell No. Plates With Fixing Pins.
13	1 Pair of Spanners
14	1 No. Acid Resisting Funnel
15	1 No. Acid Resisting Jug Of 2 Litres Capacity
16	Requisite Quantity Of Electrolyte With 10% Extra In Non-Returnable Containers
17	1 Set Of Inter Connectors.
18	Torque wrench – 2 Nos
19	One set of spanners

1.2.19 Installation and commissioning

Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor.

1.2.20 **TESTS:**

The batteries shall be tested after manufacture as per the requirements of I.S. 1651:1991 (with latest amendments if any).

1.3. **Battery Charger :**

STANDARDS.

Unless otherwise specified, the equipment shall conform to the latest applicable Indian, IEC, British or USA standards, and in particular to the following standards:-

IS:1651	Specifications For Stationery Cells And Batteries, Lead Acid Type With Tubular Positive Plates
IS:3895	Specification For Rectifier Equipments
IS:9224	Specifications For HRC Fuses
IS:1248	Indication Instruments
IS:2147	Degree Of Protection For Cubicles
IS:375	Specification For Wiring
IS:4540	Mono Crystalline Semi Conductor Rectifier Assemblies And Equipment
IS:6619	Safety Code For Semi Conductor Rectifiers
IS:2026	Transformers
IS:2959	A.C. Contractors For Voltage Not Exceeding 1000 V
IS:4237	General Requirements For Switch Gear In Control Gear For Voltage < 1000 Volts
IS:4064	Air Break Switches And Fuse Units
IS:6005	Code Of Practice For Phosphating
IS:5568	Colour For Ready Mix Paints
IS:2489, 5921	Printed Circuit Boards
IS:5578	Guide For Making Insulated Conductors

CAPACITY & RATING FOR CHARGERS.

For battery chargers of different ratings the ultimate capacity shall be designed based on the following requirements.

Requirements	48 V- 60 A	220 V- 60 A
a. TRICKLE CHARGER UNIT		
1. Load (Amperes)	60	60
2. Trickle current (mAmps)	300	300
3. Total design rating of trickle charger	61	61
b. BOOST CHARGER UNIT		
1. Load (Amperes)	60	60
2. Boost current (Amps)	60	60
3. Total requirement (Amps)	120	120

Sr. no.	Particulars	Float 220V-600AH	Boost 220V-600AH	Float 48V600AH	Boost 48V600AH
1	Type	INDOOR	INDOOR	INDOOR	INDOOR
2	Rated AC Input voltage (3Ph 4w, 415V,50Hz +/- 3%, Voltage variation 360-450V)	360 to 450VAC	360 to 450VAC	360 to 450VAC	360 to 450VAC
3	Rated Output Voltage	2.2 Vdc/Cell	2.28dc-2.7Vdc/Cell	2.2 V/Cell	2.28-2.7V/Cell
4	Regulation	1%	1%	1%	1%
5	Ripple	1% without battery	1% without battery	2 mili V sophometeric with battery & 4 mili V without battery in circuit	2 mili V sophometeric with battery & 4 mili V without battery in circuit
6	Currents	61A	120A	61A	120A
7	System output voltage	242Vdc	250 Vdc to 297 Vdc	52.8V	54.7-64.8V
8	MAIN TRANSFORMER Type of connection (Star/Delta)	Star/Delta	Star/Delta	Star/Delta	Star/Delta
9	Single/Double Wound	Double Wound	Double Wound	Double Wound	Double Wound
10	KVA Rating	22 KVA	54 KVA	4.9 KVA	11.8 KVA
11	Method of cooling	Natural Air	Natural Air	Natural Air	Natural Air
12	Whether Taps are provided for primary Volt selection	NO	NO	NO	NO
13	Class of Insulation	F Class	F Class	F Class	F Class
14	Current Density in winding	Max.1.5A/mm sq.	Max.1.5A/mm sq.	Max.1.5A/mm sq.	Max.1.5A/mm sq.
15	Temp. rise above 45 Deg. C.(max. 40 Deg)	Max. 40 Deg. C.	Max. 40 Deg. C.	Max. 40 Deg. C.	Max. 40 Deg. C.
16	Magnetising current at 415V	Max. 3%	Max. 3%	Max. 3%	Max. 3%
17	Rating of the Main Auto TXR.	----------	40Amp	----------	16Amp
18	Type of Control	Auto	Auto/Manual	Auto	Auto/Manual
19	Type and rating of smoothing filter				
	Inductor	2.2 mH/63 A		2.2mH 62A	
	Capacitor	10000 µF /350V		4700 µF /100V*5	
20	Voltage regulation				
	Inherent	1%	1%	1%	1%

	With AVR	1%	1%	1%	1%
21	Efficiency at				
	Full Load (min. 75%)	min. 75%	min. 75%	min. 75%	min. 75%
	Half load (min. 60%)	min. 60%	min. 60%	min. 60%	min. 60%
22	Rating of Rectifier				
	Current rating	75A	150A	75A	150A
	Peak inverse voltage	1200V	1200V	1200V	1200V
	Inverse voltage surge	1200V	1200V	1200V	1200V
23	Battery charger cubicle				
	a) Thickness of sheet	2 mm	2 mm	2 mm	2 mm
	b) Overall size(W.H.D.)	Minimum 1700*1600*800		Minimum 1400*1600*800	
24	Details of Cables & Wires Used in the Charger	1.5/16 sq mm	1.5/16 sqmm	1.5/16 sq mm	1.5/16 sqmm
25	Rating of Dropper Diode (min. 70A/1000V)	min. 75A/1000V	min. 150A/1000V	min. 75A/1000V	min. 150A/1000V

The DC system for 220 V DC is unearthed and for 48 V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered Lead Acid batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at 2.2 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at upto 2.6 volts per cell at the desired rate.

Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

1.3.1 All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within +1% to -1% of the set value, for AC input voltage variation of + 10%, frequency variation of +5%, a combined voltage and frequency variation of +10%, and a DC load variation from zero to full load.

1.3.2 All battery chargers shall have a constant voltage characteristics throughout the range (from zero to full load) in the floating mode of the voltage so as to keep the battery fully charged but without harmful overcharge.

1.3.3 All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short

circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

1.3.4 Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

1.3.5 During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

1.3.6. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage any where in the output range specified for Boost Charging mode.

1.3.7. The Charger manufacturer shall offer an arrangement in which the voltage across the load shall not exceed 110 % during boost charging of the battery and when cell voltage reaches even 2.6 volts. The rating of any diodes used in series with the battery and the load current shall have a minimum 200 % of the rating of maximum load current and also should take into consideration the short time DC load due to simultaneous operation of the CBs/protective relays.

1.3.8 Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.The Charger shall have DC earth leakage indicator along with a relaying ckt for extending indication

1.3.9 MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

1.3.10 Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11 Rectifier Assembly

The rectifier assembly shall be full/half controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

1.3.12 Instruments

One AC voltmeter and one AC ammeter alongwith selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V chargers for testing purpose.

1.3.13 Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be insulated from circuit.

`ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14 Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

1.3.15 Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

1.3.16 Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:

a) AC power failure
b) Rectifier/chargers fuse blown.
c) Over voltage across the battery when boost charging.
d) Abnormal voltage (High/Low)
e) DC earth leakage
f) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Owner's Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

Various alarms as well as the voltages of Chargers shall be suitably integrated in the Substation System.

1.3.17 Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance.

1.3.18 Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part I.

1.3.18.1 All indicating instruments, control switches and indicating lamps shall bemounted on the front side of the Charger.

1.3.18.2 Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3 The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19. Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be `Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) of IS:5 shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

1.3.20 **TESTS**

1.3.20.1 Battery chargers shall conform to all type tests as per relevant Indian Standard. The validity of type test conducted should be governed by the guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt of India, Ministry of power in the May 2020

Performance test on the Chargers as per Specification shall also be carried out oneach Charger as per specification. Rectifier transformer shall conform to all type tests specified in IS : 4540 and short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements:

i) Voltage regulation test
ii) Load limiter characteristics test
iii) Efficiency tests
iv) High voltage tests
v) Temperature rise test
vi) Short circuit test at no load and full load at rated voltage for sustained short-circuit.
vii) Degree of protection test
viii) Measurement of ripple by oscilloscope.
ix) Temperature compensation feature demonstration

1.3.20.2 The Contractor may be required to demonstrate to the OWNER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out :

i) Insulation resistance test
ii) Checking of proper annunciation system operation.

1.3.20.3 If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the OWNER.

1.3.20.4 The Contractor shall present for inspection, the type and routine test certificatesfor the following components whenever required by the OWNER.

(i) Switches.
(ii) Relays/ MCCBs
(iii) Instruments.
(iv) DC fuses.
(v) SCR.
(vi) Diodes.
(vii) Condensers.
(viii) Potentiometers.
(ix) Semiconductor
(x) Annunciator.
(xi) Control wiring
(xii) Push buttons and contactors. Makes of above equipment shall be subject to Owner's approval.

The control and monitoring of Battery Chargers shall be integrated into Substation Automation System. An independent BCU shall be provided in battery charger for the same.

TECHNICAL SPECIFICATION FOR AUTOMATIC DATA LOGGING SYSTEM FOR ENERGY METERS

At present there is automatic data logging system of M/s Secure integrated with APEX 100 energymeters at 220/132 KV Dhardehi. A new data logging system shall be supplied, erected and commissioned in new control room building .It shall be the responsibility of the contractor to provide necessary arrangement for integration of energy meters of existing 220 KV substation Dhardehi (including all 220 KV and 132 KV bays) and proposed 400 KV substation Dhardehi in new control room building. The existing PC, printer and furniture shall be utilised by CSPTCL after successful commissioning of new data logging system.

This feature is intended for local monitoring of Sub-station para meters on computer screen installed in control room. The objective shall be achieved with the help of customized software and hardware connection to energy meters. The data shall be collected through RS485 port on modbus / 103 / 61850 protocols. The data logging system shall be designed as per compatibility of installed IEDs. The system shall be separated from the one utilized for SAS. The automatic data logging system shall be implemented on the Secure Meters Ltd make 0.2s class APEX ABT meter. The second 0.2s class APEX ABT meter may be utilised for the SAS.

1. **Graphical user interface (GUI) based software on Windows platform.**
2. **Online views** – Tabular and Graphical. The Substation SLD mimic shall be realized on computer screen.
3. **Meter Support** – The software shall acquire data from the Secure Meters Ltd make Apex meters over ethernet and RS485 port on DLMS and MODBUS protocol.
4. **Viewing Online Data-** The software shall provide facility to monitor instantaneous electrical parameters on real time basis and disturbance recording. Online data can be viewed in graphical /tabular formats/substation SLD mimic.
5. **Extraction/Viewing Historical Data -** The load survey data shall be extracted for onward transmission. The software shall provide historical data views for analysis purpose.
6. **Group Definition -** The software shall provide facility for grouping of meters to define virtual meters. This feature shall be used for calculation of total energy consumed by a group of energy meters as well as computation of concurrent maximum demand and power factor for that group of meters.
7. **Alarm Management -** It shall provide User definable alarms for different parameters. These alarms shall be available for system monitoring on real time basis.
8. **E-mail Facility -** The software shall provide daily/weekly data in CSV (comma-separated values or character-separated values) format.
9. **Reports -** The software shall provide various types of reports like min-max, consumption, alarm data, interruption data, meter replacement, demand data, energy loss data etc.
10. **Data Import and Export -** The software shall have facility to import CSV files from a third party application. User should export the meter data to CSV format.
11. **System Architecture -** Single machine (MS Access database)
12. **Computer System Configuration -** Dual Core Processor, SDRAM-6GB, HDD-1000 GB, DVD Drive, Ethernet Card, Serial Ports -2 Nos, USB port, Color 29" LCD Monitor, Operating System – Windows 10, Laser Printer.
    Customized reports should be generated. Format for log sheets will be provided by CSPTCL.

SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL

The scope of the work is complete substation automation system of 400/220 KV S/s based on IEC 61850 protocol for 400/220KV S/s to be integrated with existing bays of 220/132 S/s Dhardehi and new proposed bays of 400/220 S/s Dhardehi in new control room building (including hardware & software with licences for local control station at Dhardehi (Bilaspur) , (Distt. Mungeli), remote control station at Raipur and communication with SLDC) alongwith associated equipments,cabinets for servers and SAS control desks, OFC/any other cable required to connect SAS/PC with BCU, relay, energymeter alongwith conduit for routing of such cable.

At present there is substation automation system of M/s GE T & D India Ltd. integrated with existing 220 KV and 132 KV bays of 220/132 KV Dhardehi. A new substation automation system shall be supplied, erected and commissioned in new control room building by the contractor. The substation automation system shall be integrated with existing bays of 220/132 S/s Dhardehi and new proposed bays of 400/220 S/s Dhardehi including hardware and software for local control stations as well as for remote control station along with associated equipments The control and monitoring of the integrated substation (existing 220 KV and 132 KV bays of 220/132 KV S/s Dhardehi+ proposed 400 KV and 220 KV bays of 400/220 KV S/s Dhardehi) shall be governed from new control room building. The exact IO points shall be decided during detailed engeneering.

All the necessary accessories and cabling (all type) are to be provided by the contractor under present scope required for successful completion of the scope of work.

1.1. The substation automation system shall be designed, manufactured, tested, installed and commissioned at the substation as per IEC-61850.

1.2. The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from Remote Control centre (RCC) as well as from Local Control Centre.

The SAS shall contain the following main functional parts:

- Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- Gateway for remote control via industrial grade hardware (to RCC) through I EC60870-5-1 01 and IEC 60870- 104 protocols.
- Gateway for remote supervisory control (to RSCC), the gateway should be able to communicate with RSCC on IEC 60870-5-101 protocol. The specific protocol to be implemented shall be asper GE's interoperability profile. It shall be the bidder's responsibility to integrate his offered system with existing RSCC system for exchange of desired data. The exact IO point shall be decided during detailed engineering
- Remote HMI.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

1.3. It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

1.4. It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.

1.5. The communication gateway shall facilitate the information flow with remote control centres. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

2. System design

2.1 General system design

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation (proposed 400 KV bays, proposed 220 KV bays of new 400/220 Substation Dhardehi and existing 220 KV bays, existing 132 KV bays of existing 220/132 KV substation) including future extensions.

The systems shall be of the state-of-the art suitable for operation under electrical environment present in Extra high voltage substations, follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered integration of existing and new proposed bays into SAS shall support remote control and monitoring from Remote Control centres via gateways.

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signalling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

Bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer), bay mimic along with relay and protection panels (described in other sections of technical specifications) housed in air-conditioned Bay roomssuitably located in switchyard and Station HMI in Control Room building for overall optimisation in respect of cabling and control room building.

2.2 System architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level.

At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing disturbance free communication. The fibre optic cables shall be run in G.I. conduit pipes. The FO cables shall be laid in two different GI pipes and shall follow different routes to make redundant ring. Data exchange is to be realised using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure

The communication shall be made in 1+1 mode, including the links between individual bay IEDs to switch, such that failure of one set of fibre and/or the switch shall not affect the normal operation of the SAS. However it shall generate alarm in SAS. Each fibre optic cable shall have four (4) spare fibres.Two numbers of Ethernet switches shall be used per bay marshalling room and these shall have sufficient numbers of spare ports.Two Numbers BCUs shall be used with each 400 KV, 220 KV and 33 KV Bay.The BCU and all the numerical protective relays shall have two nos of Ethernet ports. The network redundancy shall be ensured with Parallel Redundancy Protocol (PRP) IEC62439-3 Clause 4 or HSR (High Availability Seamless Ring), currently circulated as IEC CDV 62439-3 Clause 5.

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. RCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.The station level contains the station-oriented functions, which cannot be realised at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centres.

The GPS time synchronising signal (as specified in the section relay & protection) for the synchronization of the entire system shall be provided. A Visual Display Unit shall also be provided along with GPS at local control centre.

The SAS shall contain the functional parts as described in para 1.2 above.

2.3 FUNCTIONAL REQUIREMENTS

The high-voltage apparatus within the station shall be operated from different places:

> Remote control centres

> Station HMI.

> Local Bay controller IED (in the bays)

Operation shall be possible by only one operator at a time.

The operation shall depend on the conditions of other functions, such as interlocking, synchrocheck, etc. (see description in ”Bay level control functions”).

2.3.1 Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2.3.2 Command supervision Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for:

(a) Bus Earth switch Interlocking

(b) Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

2.3.3 Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

2.3.4 Self-supervision

Continuous self-supervision function with self-diagnostic feature shall be included.

2.3.5 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

The Functional requirement shall be divided into following levels:

a. Bay (a bay comprises of one circuit breaker andassociated disconnector, earth switches and instrument transformer) Level Functions
b. System Level Functions

3.1. Bay level functions

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control functions including data collection functionality.
- Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.Each IED shall be connected to two Ethernet switches as in PRP or two IEDs for HSR.

3.1.1. Bay control functions

3.1.1.1 Overview

Functions

- Control mode selection
- Select-before-execute principle
- Command supervision:
- Interlocking and blocking
- Double command
- Synchrocheck, voltage selection
- Run Time Command cancellation
- Transformer tap changer control (for power transformer bays)
- Operation counters for circuit breakers and pumps
- Air compressor control and runtime supervision
- Operating pressure supervision
- Display of interlocking and blocking
- Breaker position indication per phase
- Alarm annunciation
- Measurement display
- Local HMI (local guided, emergency mode)
- Interface to the station HMI.
- Data storage for at least 500 events

- Extension possibilities with additional I/O's inside the unit or via fibre-optic communication and process bus

3.1.1.2. Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

REMOTE mode

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.1.1.3. Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

> Settable voltage, phase angle, and frequency difference.
> Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchro-check function.
> Synchronising between live line and live bus with synchrocheck function

Voltage selection

The voltages relevant for the Synchrocheck functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the bay control and protection IEDs.

3.1.1.4. Transformer tap changer control

Raise and lower operation of OLTC taps of transformer shall be facilitated through a dedicated Bay controller IED.

3.1.2. Bay protection functions

3.1.2.1. General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection.

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as per detailed in section C&R

3.2. System level functions

3.2.1. Status supervision

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through these IED. Individual IEDs shall be used for Battery Chargers, Firefighting equipments and ACDB/DCDB. The data received from Online DGA monitoring device of 315 MVA & 160 MVA transformer shall be integrated into Substation Automation System.

3.2.2. Measurements

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated.

The measured values shall be displayed locally on the station HMI and in the control centre. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds. Threshold limit values shall be selectable for alarm indication.

Secure Meters Ltd make Apex Energy meter data shall also be integrated into the Substation Automation System for display of instantaneous values,data logging,data storage and data processing to present the data as customised report.The instantaneous values of V,I,P,Q and F shall be displayed as per SLD in a separate SAS screen.Any deviation in this regard shall be subject to CSPTCL's specific approval.

3.2.3. Event and alarm handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms.

3.2.4. Station HMI

3.2.4.1. Substation HMI Operation:

On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

3.2.4.2. Presentation and dialogues

General

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator. A Visual Monitoring Unit of size 55(fifty Five)inches or bigger shall additionally be provided for ease in monitoring at the Control room.

The following standard pictures shall be available from the HMI:

> Single-line diagram showing the switchgear status andmeasured values(from BCU and Apex energy meter on separate screens)
> Control dialogues with interlocking and blocking details. **This control dialogue shall tell the operator whether the device operation is permitted or blocked and shall indicate the entire interlock sequence of that particular operation.**
> Measurement dialogues
> Alarm list, station / bay-oriented
> Event list, station / bay-oriented
> System status

3.2.4.3. HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.The object status shall be indicated using different status colours for:

> Selected object under command
> Selected on the screen
> Not updated, obsolete values, not in use or not sampled
> Alarm or faulty state
> Warning or blocked
> Update blocked or manually updated
> Control blocked
> Normal state

3.2.4.4. Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be ableto recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the “execution” of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

3.2.4.5. System supervision & display

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious

situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

3.2.4.6. Event list

The event list shall contain events that are important for the control and monitoring of the substation.The event and associated time (with1 ms resolution) of its occurrence has to be displayed for each event.The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

> Position changes of circuit breakers, isolators and earthing devices
> Indication of protective relay operations
> Fault signals from the switchgear
> Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurand.
> Loss of communication.

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

> Date and time
> Bay
> Device
> Function e.g. trips, protection operations etc.
> Alarm class

3.2.4.7. Alarm list

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation Each alarm shall be reported on one line that contains:

> The date and time of the alarm
> The name of the alarming object
> A descriptive text
> The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

3.2.4.8. Object picture

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

> Type of blocking
> Authority
> Local / remote control
> RSCC / SAS control
> Errors
> etc., shall be displayed.

3.2.4.9 Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

> Breaker and disconnector
> Transformer tap-changer

3.2.5. User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus etc) within a certain user authorisation group. Each user shall then be given access rights to each group of objects, e.g.:

> Display only
> Normal operation (e.g. open/close of switchgear)
> Restricted operation (e.g. by-passed interlocking)
> System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:

> No engineering allowed
> Engineering/configuration allowed
> Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

3.2.6. Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

> Trend reports:
> Day (mean, peak)
> Month (mean, peak)
> Semi-annual (mean, peak)
> Year (mean, peak)
> Historical reports of selected analogue Values:
> Day (at 15 minutes interval)
> Week
> Month
> Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.Following printouts shall be available from the printer and shall be printed on demand:

i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
ii. Weekly trend curves for real and derived analogue values.
iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
v. Equipment operation details shift wise and during 24 hours.
vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.
vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
viii. Reports in specified formats which shall be handed over to successful bidder.
ix. Energy balance report of the 400 and 220 KV buses daily and monthly basis from both APEX energy meters of Secure Energy Meter. Formats of specified customised reports for Apex Energy meters shall be provided to the successful bidder.

3.2.7. Trend display (historical data)

It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

3.2.8. Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

3.2.9. Disturbance analysis

The PCbased work station shall have necessary software to evaluate all the required information for proper fault analysis.

3.2.10. IED parameter setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

3.2.11. Automatic sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

3.3. Gateway

3.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous SCADA protocols for communications with multiple independent remote master stations viz IEC 60870-101 and IEC 60870 -104.

The Substation Automation System shall have communication ports as follows:

(a) Two ports for Remote Control Centre

(b) Two ports for Regional System Coordination Centre (RSCC)

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each control centre. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centres (RCC & RSCC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control centre's data scan and control commands may be different for different data points within the substation automation system's database.

Hardware capability : It shall havea flexible high performance expandablediscless & fanless plateform . It should be powered by 1 GHz or better processor.It shall have networked time protocol (NTP) & IRIG B format time protocol support. It shall have centralised user authentication .It shall have built in calculative function (Math /logic).It shall have dual redundant hot swappable power supplies ensuring continuous uptime.

3.3.2 Remote Control Centre Communication Interface

CSPTCL will supply communication channels between the Substation Automation System and the remote control centre. The communication channels provided by CSPTCL will consist either of power line carrier, microwave, optical fibre, VSAT or leased line, the details of which shall be provided during detailed Engineering. The contractor shall arrange for necessary software Licences for complete control and monitoring from the Remote Control Centre.

3.3.3 **Interface equipment:**

The Contractor shall provide interface equipment with licensed software and hardware for communicating between between Substation Automation system and Remote control centre and between Substation Automation system and Regional System Coordination Centre (RSCC) for control and monitoring . However, the communication channels shall be made available for this purpose by the CSPTCL.

In case of PLCC communication, any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. **The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel.** The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.4 Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-101 ,104 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc..

4.0 System hardware:

4.1 Redundant Station HMI, HMI View Node, Remote HMI and Disturbance Recorder Work station:

The contractor shall provide redundant station HMI in hot standby mode.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 30% of disk space:

1. Storage of all analogue data (at 15 Minutes interval)and digitaldata including alarm , event and trend data for thirty(30) days,
2. Storage of all necessary software,
3. 1000 GB space for OWNER'S use.
   Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

4.1.1 **HMI (Human Machine Interface)**

The VDU shall show overview diagrams (Single Line Diagrams) andcomplete details of the switchgear with a colour display. All event andalarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

4.1.2 Visual Display Units/TFT's (Thin Film Technology)

The contractor shall provide at least four display units, one for station HMI, one for redundant HMI and one for DR work station and a bigger one for easy viewing of station HMI . These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 29" diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixels or better.

A 55 Inches or bigger size Visual Display LED full HD unit of very good resolution and capable of colour graphics shall be employed for easy viewing of station HMI from anywhere in the control room. The two HMI workstations shall have dual monitor ports so that the larger 55" Monitor may be connected on any of these as Monitor of station HMI.

4.1.3 Dot Matrix Printer (As per the choice of the CSPTCL)

It shall be robust & suitable for operation with a minimum of 132 characters per line. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All printers mounted in the control room shall be provided with a separate printer enclosure each. The enclosure shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading. The printer enclosures shall be designed to protect the printers from accidental external contact & each should be removable from hinges at the back and shall be provided with lock at the front.

All reports and graphics prints shall be printed on laser printer. One dot matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously on line.

4.1.4 SERVER/WORK STATION: These shall have following or better specifications;

Specifications for SCADA servers – Main & standby with OS software

Xeon ®Processor E5504 (2.00GHz, 6MB L3 Cache, 80W,DDR3-800)/Integrated 1x4 MB L3 cache/6 GB(2X2 GB) PC3 10600E PC3-Un-buffered ECC memory/1000GB* 2 Nos SATA 7.2k NHP 3.5" NHP HDD /Embedded NC 107i PCI Express Gigabit Server Adapter/RAID 0,1,0+1/ 460W Non-Hot Plug,Non-redundant Power Supply(70% efficiency)/ Half-Height SATA DVD-ROM Optical Drive/3-1-1 Warranty.DUAL MONITOR PORT. Dual redundant poer supply. Dual HDMI port

Specifications for SCADA DATABASE Server –Monitors &OS software

Xeon® Processor E5620(2.40GHz, 12MB L3 Cache ,80W,DDR3-1066, HT ,TURBO (1/1/2/2) /12MB (1X12MB) L3 cache/6GB (3X2GB)PC3-10600R(DDR3-1333)Registered DIMMs/Embedded NC326i PCI Express Dual Port Gigabit Server Adapter/Embedded Smart Array P410i/256MB C t II /(8) SFF SAS/SATA HDD Bays; up gradable to (16) /SATA DVD ROM/(1) 460 Watt Hot –Plug (Redundancy enabled)power supply/3 fans ship standard/5u/3-3-3 Warranty/Keyboard & Optical Mouse/29" TFT Monitor. Dual redundant poer supply. Dual HDMI port

HMI Server/Operator Work Station(OWS) & DR PC with Monitor & OS Software

7100 CORE I3 540/4GB DDR3 RAM/320 GB HDD/WIN 7 PROFESSIONAL/DVD WRITER/KEYBOARD & OPTICAL MOUSE/29" TFT MONITOR/3-3-3 WARRANTY/ PCI DUAL PORT LAN CARD. Dual redundant poer supply. Dual HDMI port

4.1.5 Switched Ethernet Communication Infrastructure:

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 100% spare capacity for employer use. TwoEthernet switches shall be provided to connect all IEDs in Bay Control Room of each 400kV yard and 220KV yard to communication infrastructure.

4.2 Bay level unit

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours. Adequate numbers of Ethernet switches shall be provided per Bay control room as per requirement of PRP or HSR network topology.

Two nos. IEC 61850 compliant Bay level unit shall be provided for supervision and control of each 400 KV, 220 kV and 33 KV bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated

in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

4.2.1 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. There shall be 25 % spare each ofinput and output contacts over and above that utilised for the complete scheme per bay control unit.

4.3 Air-conditioned Bay Marshalling Rooms

The Air-conditioned bay Marshalling Rooms offered shall house relay and protection panels, etc. one each for a diameter in 400kV level and one for 220kV Level. In case of incomplete diameter the rooms shall have necessary space for accommodating the future bay IEDs. The layout of equipment/panel shall be subject to Owner's approval. The Rooms shall be provided with fire alarm system with at least two detectors and it shall be wired to SAS.Two nos physically independent split air conditioners of at least 2T capacity each shall be provided with auto change over scheme.The air conditioner provided in Bay Room shall be controlled and monitored from substation automation system. One additional Room for each voltage level, if required, shall be provided for housing bus bar protection panels at suitable location in switchyard.

4.4 Extendibility in future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future.

5.0 Software structure

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

5.1.1 Station level software

5.1.1.1 Human-machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and

system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

5.1.2 Bay level software

5.1.1.1 System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronising with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

5.1.1.2 Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library.

The application software within the control/protection devices shall be programmed in a functional block language.

5.1.1.3 Network Management System:

The contractor shall provide a network management system software for following management functions:

a. Configuration Management
b. Fault Management
c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR workstation and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

(a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
(b) Maintain a graphical display of SAS connectivity and device status.
(c) Issue alarms when error conditions occurs
(d) Provide facility to add and delete addresses and links

5.1.1.4 The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

6.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

6.1 Type Tests:

6.1.1 Control IEDs and Communication Equipment:

a. Power Input:

i. Auxiliary Voltage
ii. Current Circuits
iii. Voltage Circuits
iv. Indications

b. Accuracy Tests:

i. Operational Measured Values
ii. Currents
iii. Voltages
iv. Time resolution

c. Insulation Tests:

i. Dielectric Tests
ii. Impulse Voltage withstand Test

d. Influencing Quantities

i. Limits of operation
ii. Permissible ripples
iii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

i. 1 MHZ. burst disturbance test
ii. Electrostatic Discharge Test
iii. Radiated Electromagnetic Field Disturbance Test
iv. Electrical Fast transient Disturbance Test
v. Conducted Disturbances Tests induced by Radio Frequency Field
vi. Magnetic Field Test
vii. Emission (Radio interference level) Test.
viii. Conducted Interference Test

f. Function Tests:

i. Indication
ii. Commands
iii. Measured value Acquisition
iv. Display Indications

g. Environmental tests:

i. Cold Temperature
ii. Dry Heat
iii. Wet heat
iv. Humidity (Damp heat Cycle)
v. Vibration
vi. Bump
vii. Shock

6.2 Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.

6.3 Integrated Testing;

6.3.1 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. . The vendor specifically demonstrates how to add a device in future in SAS during FAT. The device shall be from a different manufacturer than the SAS supplier

6.3.2 Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

6.4 Field Tests:

The field tests shall completely verify all the features of SAS hardware and software.

7.0 SYSTEM OPERATION

7.1 Substation Operation

7.1.1 NORMAL OPERATION

Operation of the system by the operator from the remote RCC or at the substation shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields:

i) Message field with display of present time and date
ii) Display field for single line diagrams
iii) Navigation bar with alarm/condition indication

For display of alarm annunciation, lists of events etc, a separate HMI View node. shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish betweenPrompting of indications e.g. fault indications in the switchgear, andprompting of operational sequences e.g. execution of switching operations

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be

supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

8.0 POWER SUPPLY

Power for the substation automation system shall be derived from Substation 220V DC system.

Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown and restart.

9.0 DOCUMENTATION

The following documents shall be submitted for employer's approval during detailed engineering:

(a) System Architecture Drawing
(b) Hardware Specification
(c) Sizing Calculations of various components
(d) Response Time Calculation
(e) Functional Design Document

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings to be provide in "dxf" format.

- List of Drawings
- Substation automation system architecture
- Block Diagram
- Design specification and Guaranteed availability and reliability
- Calculation for power supply dimensioning
- I/O Signal lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- Bay Room layout drawing
- GA of Bay Room and GTP
- Control Room Lay-out
- Test Specification for Factory Acceptance Test (FAT)
- Product Manuals
- Assembly Drawing
- Operator's Manual
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering

  Two sets of hard copy and Four sets of CD ROM containing all the as built documents/drawings shall be provided.

10.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

10.1 Training

Contractor personnel who are experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on its own cost all hardware training platform required for successful training and understanding in

India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer.

For all training courses, the travelling (e.g., airfare) and lodging expenses will be borne by the participants.

The schedule, location, and detailed contents of each course will be finalized during Employer and Contractor discussions.

10.2 Computer System Hardware Course

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

(a) System Hardware Overview: Configuration of the systemhardware.

(b) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipments.

(c) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.

(d) System Maintenance: Theory of operation and maintenance ofthe redundant hardware configuration, failover hardware, configuration control panels, and failover switches.

Maintenance of protective devices and power supplies.

(e) Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

(f) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer equipment, or on similarly configured systems.

10.3 Computer System Software Course

The Contractor shall provide a computer system software course that covers the following subjects:

(a) System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. Anintroduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of thesystem.

(b) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and

procedures

(c) System Initialization and Failover: Including design, theory of operation, and practice

(d) Diagnostics:Including the execution of diagnostic proceduresand the interpretation of diagnostic outputs,

(e) Software Documentation: Orientation in the organization and useof system software documentation.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.4 Application Software Course

The Contractor shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include:

(a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

(b) Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.

(c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

(d) Software Generation: Generation of application software from source code and associated software configuration control procedures.

(e) Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.5 Requirement of training:

The contractor shall provide training for two batches for two weeks each for following courses.

S. No.	Name of Course
1.	Computer System Hardware
2.	Computer System Software
3.	Application Software

11.0 Maintenance

11.1 Maintenance Responsibility during the Guaranteed Availability Period.

During Guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

12.0 RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well-tested hardware
- Thoroughly developed and tested modular software

- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
- Experience of security requirements
- Process know-how
- Select before execute at operation
- Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding immune against transient ground potential rise

Outage terms

1) **Outage**
The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 7.1 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/ system other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.
2) **Actual outage duration (AOD)**
The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than $1/4^{th}$ of an hour shall be counted as having duration of $1/4^{th}$ of an hour.
3) **Period Hours (PH)**
The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).
4) **Actual Outage hours (AOH)**
The sum of actual outage duration within the reporting period AOH = $\sum$ AOD
5) **Availability:**
Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

12.1 Guarantees Required

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is

considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

13.0 Spares

13.1 Consumables:

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the owner. .

13.2 Availability Spares:

In addition to mandatory spares as listed for SAS, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period, the spare parts supplied by the Contractor shall be made available to the Contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Contractor) would have to be supplied immediately by the Contractor free of cost to the Employer.

14.0 LIST OF EQUIPMENTS

Quantity of equipments shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

Following Minimum Quantity of equipments as per tender specifications (but not limited to) shall be supplied;

i) SCADA servers (in Hot-stand by mode) : Two nos with 29 Inch LED Monitors
ii) SCADA standby server : 1 No with 29 Inch LED Monitor
iii) Station HMI and Redundant Station HMI (in Hot-stand by mode HMI): Two nos (OWS 1 and 2) with 29 Inch LED Monitors
iv) Large 55" VDU as specified : 1 no
v) Engg and Disturbance Recorder Work Station with 29 Inch LED Monitor (Maintenance HMI): 1 No
vi) Two Nos Bay level units for each 400KV,220 KV and 33 KV Bay along with bay mimic (Item included in Protection panels of Price Annexure B-1 ,B-2 & B-3)
vii) Minimum Two Nos Ethernet switches per Bay Marshalling Room (with 100 % redundant ports or an additional Ethernet switch to ensure redundancy of ports)
viii) Colour Laser Printer – 2 No. (For Reports & Disturbance records)
ix) Dot matrix printers – (one each for Alarms and log sheets)
x) All interface equipment for gateway to RCC and RSCC
xi) Communication infrastructure between Bay level units, Station HMI, Printers, redundant LAN etc. as required
xii) Gateways in Hot- Stand by mode along with two numbers modems each for local and remote ends (RCC and RSCC) also.
xiii) Remote workstation including HMI (29 Inch LED Monitor) and along with one printer
xiv) Other equipments as detailed above in SAS section and any other necessary for SAS and not listed.
xv) One No. additional HMI view node (with 29 Inch LED Monitor) shall be provided in the office of Station incharge also.
xvi) 5 KVA or higher size pure sine wave inverters as per requirement : 2 Nos
xvii) One KVA pure sine wave inverter : 01 No.

Any other addition over and above this list of equipments shall be proposed by bidder and decided by CSPTCL as per tender specification in order to achieve guaranteed reliability and availability as declared by bidder.

Basic Monitoring requirements are:

- Switchgear status indication
- Measurements (U, I, P, Q, f)
- Event (including fault current, Fault Location and other fault data if applicable)
- Alarm
- Winding/oil temperature of transformers(315 MVA and 160 MVA) & reactors
- ambient temperature
- Status and display of 415V LT system, 220V & 48V DC system
- Status of display of Fire protection system and Air conditioning system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
- Acquisition of alarm and fault record from protection relays
- Disturbance records
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap-position of Transformer

List of Inputs

The list of input for typical bays is as below:-

Analogue inputs

i) For line
Current R phase,Y phase, B phase
Voltage R-Y phaseY-B phase B-R phase

ii) For transformer/reactor
Current R phase, Y phase , B phase
WTI (for transformer and reactor)
Tap position (for transformer only)

iii) For TBC and bus coupler
Current R phase, Y phase,B phase

iv) Common
a) Voltage for Bus-I, Bus-II and Transfer bus wherever applicable
VoltageR-Y phaseY-B phase B-R phase
b) Frequency for Bus-I and Bus-II
c) Ambient temperature (switchyard).
d) LT system
i) Voltage R-Y, Y-B, B-R of Main Switch Boardsection-I
ii) Voltage R-Y, Y-B, B-R of Main Switch Boardsection-II
iii) Voltage R-Y, Y-B, B-R of Diesel Generator
iv) Current from LT transformer-I
v) Current from LT transformer-II
vi) Current from Diesel Generator
vii) Voltage of 220V DCDB-I
viii) Voltage of 220V DCDB-II
ix) Current from 220V Battery set-I
x) Current from 220V Battery set-II
xi) Current from 220V Battery charger-I
xii) Current from 220V Battery charger-I

xiii) Voltage of 48V DCDB-I
xiv) Voltage of 48V DCDB-II
xv) Current from 48V Battery set-I
xvi) Current from 48V Battery set-II
xvii) Current from 48V Battery charger-I
xviii) Current from 48V Battery charger-I
xix) Voltage R-Y, Y-B, B-R of Main Switch Boardfor external LT supply

Digital Inputs

The list of input for various bays/SYSTEM is as follows:

1. Line bays
   i) Status of each pole of CB, Isolator, Earth switch
   ii) CB trouble
   iii) CB operation/closing lockout
   iv) Pole discrepancy optd
   v) Trip coil faulty
   vi) LBB optd
   vii) Bus bar protn trip relay optd
   viii) Main bkr auto recloser operated
   ix) Tie/transfer auto recloser operated
   x) A/r lockout
   xi) Tie/transfer bkr a/r lockout
   xii) Direct trip-I/II sent
   xiii) Direct trip-I/II received
   xiv) Main I/II blocking
   xv) Main I/II-Inter trip send
   xvi) Main I/II-Inter trip received
   xvii) O/V STAGE – I operated
   xviii) O/V STAGE – II operated
   xix) FAULT LOCATOR FAULTY
   xx) MAIN-I/II CVT FUSE FAIL
   xxi) MAIN-I PROTN TRIP
   xxii) MAIN-II PROTN TRIP
   xxiii) MAIN-I PSB ALARM
   xxiv) MAIN-I SOTF TRIP
   xxv) MAIN-I R-PH TRIP
   xxvi) MAIN-I Y-PH TRIP
   xxvii) MAIN-I B-PH TRIP
   xxviii) MAIN-I START
   xxix) MAIN-I/II Carrier aided trip
   xxx) MAIN-I/II fault in reverse direction
   xxxi) MAIN-I/II ZONE-2 TRIP
   xxxii) MAIN-I/II ZONE-3 TRIP
   xxxiii) MAIN-I/II weak end infeed optd
   xxxiv) MAIN-II PSB alarm
   xxxv) MAIN-II SOTF TRIP
   xxxvi) MAIN-II R-PH TRIP
   xxxvii) MAIN-II Y-PH TRIP
   xxxviii) MAIN-II B-PH TRIP
   xxxix) MAIN-II start
   xl) MAIN-II aided trip
   xli) MAIN-I/II fault in reverse direction

xlii) Back-up o/c optd
xliii) Back-up e/f optd
xliv) 220V DC-I/II source fail
xlv) SPEECH CHANNEL FAIL

2. Transformer bays
i) Status of each pole of CB, Isolator, Earth switch
ii) CB trouble
iii) CB operation/closing lockout
iv) Pole discrepancy optd
v) Trip coil faulty
vi) LBB optd
vii) Bus bar protn trip relay optd
viii) REF OPTD
ix) DIFF OPTD
x) OVERFLUX ALARM (MV)
xi) OVERFLUX TRIP (MV)
xii) OVERFLUX ALARM (HV)
xiii) OVERFLUX TRIP (HV)
xiv) HV BUS CVT % FUSE FAIL
xv) MV BUS CVT % FUSE FAIL
xvi) OTI ALARM/TRIP
xvii) PRD OPTD
xviii) OVERLOAD ALARM
xix) BUCHOLZ TRIP
xx) BUCHOLZ ALARM
xxi) OLTC BUCHOLZ ALARM
xxii) OLTC BUCHOLZ TRIP
xxiii) OIL LOW ALARM
xxiv) back-up o/c (HV) optd
xxv) back-up e/f (HV)optd
xxvi) 220v DC-I/II source fail
xxvii) TAP MISMATCH
xxviii) GR-A PROTN OPTD
xxix) GR-B PROTN OPTD
xxx) back-up o/c (MV) optd
xxxi) back-up e/f (MV)optd

3. **Reactor bays**
i) Status of each pole of CB, Isolator, Earth switch
ii) CB trouble
iii) CB operation/closing lockout
iv) Pole discrepancy optd
v) Trip coil faulty
vi) LBB optd
vii) Bus bar protn trip relay optd
viii) REF OPTD
ix) DIF OPTD
x) HV BUS CVT 1/2 FUSE FAIL
xi) OTI ALARM/TRIP
xii) PRD OPTD
xiii) BUCHOLZ TRIP
xiv) BUCHOLZ ALARM
xv) OIL LOW ALARM

xvi) Back-up impedance relay
xvii) 220v DC-I/II source fail
xviii) GR-A PROTN OPTD
xix) GR-B PROTN OPTD

4 Busbar Protection
i) Bus bar main-I trip
ii) Bus bar main-II trip
iii) Bus bar zone-I CT open
iv) Bus bar zone-II CT open
v) Bus transfer CT sup. Optd
vi) Bus transfer bus bar protn optd
vii) Bus protection relay fail

5. Auxiliary system
i) Incomer-I On/Off
ii) Incomer-II On/Off
iii) 415V Bus-I/II U/V
iv) 415v bus coupler breaker on/off
v) DG set bkr on/off
vi) Alarm/trip signals as listed in Section: DG set
vii) LT transformer-I Bunchholz Alarm & trip
viii) LT transformer-II Bunchholz Alarm & trip
ix) LT transformer-I WTI Alarm & trip
x) LT transformer-II WTI Alarm & trip
xi) LT transformer-I OTI Alarm & trip
xii) LT transformer-II OTI Alarm & trip
xiii) Time sync. Signal absent
xiv) Alarm/trip signals as listed in Section: Battery and Battery charger
xv) 220v dc-I earth fault
xvi) 220v dc-II earth fault
xvii) Alarm/trip signals as listed in Section: Fire protection system
xviii) Incomer of external power supply ON/OFF.
xix) External power supply transformer Buchholz Alarm & trip.
xx) External power supply transformer WTI Alarm & trip.
xxi) External power supply transformer OTI Alarm & trip.

The exact number and description of digital inputs shall be as per detailed engineering requirement Apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for CSPTCL use in future.

Air-Conditioning of Bay Marshalling Room:

The air conditionings system shall be provided in the Bay marshalling Rooms to be used for housing panels having control and protection IEDs for performing sub-station automation and protection functions generally confirm to relevant IS codes as detailed in section GTR.Two nos physically independent split airconditioners of Two tonnes each shall be provided with auto changeover scheme.The changeover scheme shall be presented for approval of CSPTCL. These bayrooms shall be placed in the switchyard area generally unmanned; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life.The control and monitoring of the Air conditioning system of Bay Marshalling Romms shall be integrated into Susb Station Automation System.

Operation:

The air conditioning is required for critical application i.e. for maintaining the temperature for critical sub-station control and protection equipment. To provide

redundancy for such critical applications, each bayroom shall be installed with environment control system comprising of two physically indepndent units of air conditioners working in conjunction through a micro processor based controller for desired operation. The system shall be designed for 24 Hours, 365 Days of the year to maintain the inside room temperature for proper operation of the critical equipment. One of the air-conditioner shall be running at a time and on failure of the same or as described hereunder, the other unit shall start automatically. To ensure longer life of the system, the redundant units shall also be running in cyclic operation through the controller. However, during running of one air-conditioner unit, if inside temperature of the shelter reaches to a predefined (i.e. 32^{o}C), the other unit shall start running to maintain the temperature to specified value (i.e. $23+2^{o}$C) and gives alarm for such situation. After achieving this temperature, the other unit shall again shut off.

Sequence of Operation of the Unit:

Suitable arrangement shall be made to operate the unit in the following order. However, the actual operation arrangement shall be finalised during detailed engineering.

1. Evaporator Fan
2. Condenser Fan.
3. Compressor

Construction:

The air conditioning unit shall be split type. All components of the units shall be enclosed in a powder coated cabinet and colour of same shall be matched room. The unit shall be assembled, wired, piped, charged with refrigerant and factory tested as a system to ensure trouble free installation and start up. Suitable isolation or other by passing arrangement shall be provided such that any unit/component could be maintained/repaired without affecting the running standby unit. The maintenance of unit shall be possible from outside the Bayroom.

Required Features of Various Components:

The compressor shall be very reliable, trouble free and long life i.e. hermitically sealed Scroll type of reputed make suitable for operation. Compressor should be installed on vibration isolated mountings or manufacturer's recommended approved mounting. Valve shall be provided for charging/topping up of refrigerant. The bidder shall furnish details of their compressor indicating the MTBF, life of compressor and continuous run time of compressor without failure. The contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower filter, cabinet, indoor supply and return grill etc.

The Bay room shall be erected at least 500 mm above the finished ground level with suitable pedestal to avoid any entry of water.

Note:

1. The redundant managed bus shall be realized by high speed optical bus (Minimum 1 GBPS or 100 MBPS subject to specific approval of CSPTCL) using industrial grade components and shall be as per IEC 61850.The IEDs and switches for each of the dia. of 400kV shall have separate BayRoom. For 220kV yards, IED for two bays can be housed in one Bay room along with its switches.
2. The network redundancy shall be ensured with Parallel Redundancy Protocol (PRP) IEC62439-3 Clause 4 or HSR (High Availability Seamless Ring), currently circulated as IEC CDV 62439-3 Clause 5.Inside sub-station,connections shall be ralized as per IEC 61850 protocol.
3. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-5-101 protocol.

4. The routine to Remote Control Centre (RCC) shal communicate on IEC 60870-5-101 and IEC 60870-5-104 protocol. .
5. The printer as required shall be connected to station bus directly and can be managedeither from station HMI, HMI view node or disturbance recorder workstation.
6. The requirement of hardware shall be as indicated in the tentative SAS layout enclosed with the tender.

SECTION: DIESEL GENERATOR SET

1.1. SCOPE OF SUPPLY

1.1.1. The scope covers supply of. Diesel Generator set of stationary type having a net electrical output of 250 kVA capacity at specified site conditions of 50^{o} C ambient temperature and 100% relative humidity on FOR site basis. DG set shall be equipped with :

(i) Diesel engine complete with all accessories.
(ii) An alternator directly coupled to the engine through coupling, complete with all accessories.
(iii) Automatic voltage regulator.
(iv) Complete starting arrangement, including two nos. batteries & chargers.
(v) Base frame, foundation bolts etc.
(vi) Day tank of 990 Litre capacity.
(vii) Engine Cooling and lubrication system.
(viii) Engine air filtering system.
(ix) Exhaust silencer package.
(x) Set of GI pipes, valves, strainers, unloading hose pipes as required for fuel transfer system from storage area to fuel tank including electrically driven fuel pump.
(xi) All lubricants, consumable, touch up paints etc. for first filing, testing &commissioning at site. The fuel oil for first commissioning will also be provided by the contractor.
(xii) AMF panel for control, metering and alarm.
(xiii) Enclosure for silent type D.G. Set

1.2. SCOPE OF SERVICE

1.2.1. The Contractor shall provide following services:

a) Design, manufacture, shop testing including assembly test.
b) Despatch, transportation to site.
c) Erection, testing & commissioning with all equipments/materials required for the purpose.
d) Drawings, data, design calculations and printed erection, operation & maintenance manual.
e) Certification and compliance for meeting noise level & emission parameters and
other requirements in accordance with latest Notification of MOEF.

1.3. TECHNICAL REQUIREMENTS

1.3.1. The rating of DG sets are as follows :

1.3.1.1. DG set net out put after considering deration for engine and alternator separately due to temperature rise in side the enclosure and on account of power reduction due to auxiliaries shall be 250kVA, 1500RPM, 0.8Pf, 415V, 3 phase, 50Hz. The above ratings are the minimum requirements.

1.3.1.2. DG sets shall also be rated for 110% of full load for 1 hour in every twelve hrs ofcontinuous running.

1.3.2. The output voltage, frequency and limits of variation from open circuit to full load shallbe as follows :

a) Voltage variation +5% of the set value provision shall exist to adjust the set value between 90% to 110% of nominal Generator voltage of 415V.
b) Frequency 50Hz +2%

1.3.3. The Diesel Generator and other auxiliary motor shall be of H class with temperature riselimited to Class-F for temperature rise consideration.

1.3.4. NOISE LEVEL & EMISSION PARAMETERS : These shall be as per latest Notificationof MOEF

1.4. **PLANT DESIGN**

1.4.1. DIESEL ENGINE

1.4.1.1. The engine shall comply with the IS 10002/BS 5514/ISO 3046; latest edition

1.4.1.2. Diesel engine shall be turbo charged multicylinder V-type in line type with mechanicalfuel injection system.

1.4.1.3. The engine with all accessories shall be enclosed in a enclosure to make it work Silently(within permissible noise level) without any degradation in its performance.

1.4.1.4. The Diesel Engines shall be directly water cooled. Cooling of water through radiator andfan as envisaged.

1.4.1.5. The fuel used shall be High Speed Diesel oil (HSD) or Light Diesel Oil (LDO) as perIS: 1460.

1.4.2. Air Suction & Filtration

1.4.2.1. Suction of air shall be from indoor for ventilation and exhaust flue gasses will be let out tooutside atmosphere, Condensate traps shall be provided on the exhaust pipe.

1.4.2.2. Filter shall be dry type air filter with replaceable elements.

1.4.3. **FUEL AND LUBRICATING OIL SYSTEM**

1.4.3.1. The engine shall have closed loop lubricating system. No moving parts shall require lubrication by hand prior to the start of engine or while it is in operation.

1.4.4. **ENGINE STARTING SYSTEM**

1.4.4.1. Automatic electric starting by DC starter motor shall be provided.

1.4.5. **FUEL INJECTION AND REGULATOR**

1.4.5.1. The engine shall be fitted with electronic governor suitable for class A-1 as per IS 10000.

1.4.5.2. The engine shall be fitted with a heavy, dynamically balanced fly wheel suitable forconstant speed governor duty.

1.4.6. **ALTERNATOR**

1.4.6.1. The alternator shall comply with BS 2613/IS 4722/IEC 34; latest edition.

1.4.6.2. The alternator shall be of continuously rated duty, suitable for 415 V, 3 phase, 50 Hz.Power development having brush-less, synchronous, self-excited, self-regulating system.

1.4.6.3. The alternator shall be drip-proof, screen protected as per IP-23 degree of Protection.

1.4.6.4. The rotor shall be dynamically balanced to minimize vibration.

1.4.6.5. The alternator shall be fitted with shaft mounted centrifugal fan.

1.4.6.6. It shall have the winding of class H but limited to Class-F for temperature rise consideration.

1.4.6.7. The Alternator regulator shall be directly coupled to the engine and shall be complete with the excitation system, automatic voltage regulation of +/- 1%, voltage adjusting potentiometer and under/over speed protection.

1.4.6.8. **Terminal Box**

1.4.6.8.1 Six (6) output terminals shall be provided in alternator terminal box. Terminals shall be Suitable for 1 No. of single core, 630 mm^2 XLPE cables per phase for 250kVA DG set and 3 1/2Core 300 mm^2 XLPE cable for 250kVA DG set. The neutral shall be formed in AMF panel. The generator terminal box shall be suitable to house necessary cables and should be made of non-magnetic material.

1.4.6.9. The alternator with all accessories shall be enclosed in a enclosure to make it workSilently (within permissible noise level)

1.4.7. COUPLING

1.4.7.1. The engine and alternator shall be directly coupled by means of self-aligning flexibleflange coupling to avoid misalignment.

1.4.7.2. The coupling shall be provided with a protecting guard to avoid accidental contract.

1.4.8. MOUNTING ARRANGEMENT

1.4.8.1. The engine and alternator shall be mounted on a common heavy duty, rigid fabricatedsteel base frame constructed from ISMC of suitable sections.

1.4.8.2. Adequate number of anti-vibration mounting pads shall be fixed on the common base frame on which the engine and the alternator shall be mounted to isolate the vibration from passing on to the common base frame or the foundation of the D.G. Set.

1.4.9. **PERIPHERALS**

1.4.9.1. **FUEL TANK**

1.4.9.1.1 The Fuel tank of 1500 Litre capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent, an air breather and necessary piping. The tank shall be painted with oil resistant paint and shall be erected in accordance with Indian explosive act of 1932. Fuel tank shall be kept outside of enclosure. The fuel piping shall be carried out to connect the D.G set kept inside.

1.4.9.1.2. For transferring fuel to Fuel tank transfer pump is envisaged. The capacity of transfer pump shall be adequate to fill the day tank in about 30 minutes. Fuel pump shall be electrically driven.

1.4.9.2. **BATTERY and BATTERY CHARGER**

1.4.9.2.1. Two nos. 24V batteries complete with all leads, terminals and stand shall be provided. Each battery shall have sufficient capacity to give 10 nos. successive starting impulse to the diesel engine.

1.4.9.2.2. The battery charger shall be complete with transformer, suitable rating (415 V, 3 Ph., 50 Hz./230V, 1Ph., 50 Hz) rectifier circuit, charge rate selector switch for "trickle"/'boost' charge, D.C. ammeter & voltmeter, annunciation panel for battery charge indication / loading / failures.

1.4.9.2.3. The charger shall float and Boost Charge the battery as per recommendation of manufacturer of battery. The charger shall be able to charge a fully discharged battery to a state of full charge in 8 Hrs. with 25% spare capacity.

1.4.9.2.4. Manual control for coarse and fine voltage variation shall be provided. Float charger shallhave built-in load limiting features.

1.4.9.2.5. Ripple shall not be more than 1%(r.m.s) to get smooth DC voltage shall be provided.

1.4.9.2.6. Charger shall be provided with Out-put Voltmeter & Ammeter.

1.4.9.2.7. Changeover scheme for selecting battery and battery charger by changeover switchshould be provided.

1.5. **CONTROL AND INSTRUMENTATION**

1.5.1. Each D.G. Set shall be provided with suitable instruments, interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, control, monitoring and safe operation of the unit. One local AMF control panel alongwith each D.G. set shall be provided by the Supplier to accommodate these instruments, protective relays, indication lamps etc. The AMF Panel shall have IP-52 degree of Protection as per IS:12063.

1.5.2. The D.G. sets shall be provided with automatic start facility to make it possible to takefull load within 30 seconds of Power Supply failure.

1.5.3. Testing facility for automatic operation of D.G.Set shall be provided in AMF panel.

1.5.4. A three attempt starting facility using two impulse timers and summation timer for engine shall be proved and if the voltage fails to develop within 40 sec. from receiving the first impulse, the set shall block and alarm to this effect shall be provided in the AMF panel.

1.5.5. Following instruments shall be provided with Diesel Engine
- a) Lub oil pressure gauge
- b) Water temperature thermometers
- c) Engine tachometer/HR
- d) Any other instruments necessary for DG Set operation shall be provided.

1.5.6. DG set shall be capable of being started/ stopped manually from remote as well as local. (Remote START/STOP push button shall be provided in 415V ACDB). However, interlock shall be provided to prevent shutting down operation as long as D.G. Circuit breaker is closed.

1.5.7. The diesel generator shall commence a shutdown sequence whenever any of the followingconditions appear in the system :
- a) Overspeed
- b) Overload
- c) High temperature of engine and cooling water.
- d) High temperature inside enclosure
- e) Low lube oil pressure
- f) Generator differential protection
- g) Short circuit protection
- h) Under voltage
- i) Over voltage
- j) Further interlocking of breaker shall be provided to prevent parallel operation of DG set with normal station supply.

1.5.8. Following indication lamps for purposes mentioned as under shall be provided in AMF panel :

1.5.8.1. Pilot indicating lamp for the following :
- a) Mains ON
- b) Alternator ON
- c) Charger ON/OFF
- d) Breaker ON/OFF
- e) Main LT Supply ON/OFF

1.5.8.2. Visual annunciation shall be provided for set shut down due to :
- a) engine overheating
- b) low oil pressure
- c) lack of fuel
- d) Set failed to start in 30 secs after receiving the first start impulse
- e) high cooling water temperature
- f) Low level in daily service fuel tank
- g) Overspeed trip
- h) Audio & visual Annunciation for alternator fault.

1.5.9. Thermostatically controlled space heaters and cubicle illumination operated by Door Switch shall be provided in AMF panel. Necessary isolating switches and fuses shall also be provided.

1.5.10. AMF panel shall have facility for adjustment of speed and voltage including fineadjustments in remote as well as in local mode.

Following shall also be provided in AMF panel:
- a) Frequency meter
- b) 3 Nos. single phase CT's for metering
- c) 3 Nos. (Provided by LT swgr manufacturer) single phase CT's with KPV 300V &RCT 0.25 ohm for differential protection of DG Set on neutral side.
- d) One (1) DC Ammeter (0-40A)
- e) One (1) DC Voltmeter (0-30V)

f) One (1) Voltmeter Selector switch
g) One (1) AC Ammeter
h) One (1) AC Voltmeter
i) Three (3) Timers (24V DC)
j) Two (2) Auto/Manual Selector Switch
k) Two (2) Auto/test/Manual Selector Switch
l) Eleven (11) Aux. Contactors suitable for 24V DC
m) One (1) Motorised potentiometer for voltage adjustment
n) Two (2) Set Battery charger as specified in Technical Specification
o) One (1) Set Phase & Neutral busbars.
p) Any other item required for completion of Control scheme shall be deemed to be included.

1.6. D.G. SET Enclosure

1.6.1. General requirements

1.6.1.1. Diesel engine, alternator, AMF panel, Batteries and Chargers shall be installed outdoor in a suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. Further, in addition to the weather proofing, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure DG set shall meet the requirement of MOEF The diesel generator sets should also conform to Environment (Protection) Rules, 1986 as amended. An exhaust fan with louvers shall be installed in the enclosure for temperature control inside the enclosure. The enclosure shall allow sufficient ventilation to the enclosed D.G. Set so that the body temperature is limit to 50°C. The air flow of the exhaust fan shall be from inside to the outside the shelter. The exhaust fan shall be powered from the DG set supply output so that it starts with the starting of the DG set and stops with the stopping of the DG set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.

1.6.1.2. Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A chicken mess shall be provided for air inlet at suitable location in enclosure which shall be finalised during detailed engineering.

1.6.1.3. The Enclosure shall be designed and the layout of the equipment inside it shall be suchthat there is easy access to all the serviceable parts.

1.6.1.4. Engine and Alternator used inside the Enclosure shall carry theirmanufacturer's Warrantyfor their respective Models and this shall not degrade their performance.

1.6.1.5. Exhaust from the Engine shall be let off through Silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.

1.6.2. All the Controls for Operation of the D.G. Set shall be easily assessable. There should beprovision for emergency shut down from outside the enclosure.

1.6.3. Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.

1.6.4. Construction Features:

1.6.4.1 The enclosure shall be fabricated from at least 14 Gauge CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by Seven Tank Process and Powder coated (PURO Polyester based) both-in side and out side – for long life. The hard-ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions.

1.6.4.2. Doors shall be large sized for easy access and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type.

1.6.4.3 The Enclosure shall be provided with anti-vibration pads (suitable for the loads and vibration they are required to carry) with minimum vibration transmitted to the surface the set is resting on.

1.6.4.4. High quality rock wool of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof.

1.6.5. Provision for Neutral/Body Earthing

1.6.5.1. Points shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through insulator mounted on enclosure.

1.7. INSTALLATION ARRANGEMENT

1.7.1. DG set enclosed in enclosure shall be installed on Concrete Pedestal 300mm above FGL

1.8. DOCUMENTS

1.8.1. Following drawings and data sheet shall be submitted for approval:

(i) Data sheet for Engine, Alternator, Battery, AMF panel and Enclosure
(ii) GA drawing of DG set
(iii) Layout of DG set in the enclosure along with sections
(iv) GA and schematic of AMF panel
(v) Arrangement of inclined roof and pedestal.

1.8.2. The DG Set shall be supplied with

(i) DG Set test certificate
(ii) Engine Operation & maintenance Manual.
(iii) Engine Parts Catalogue.
(iv) Alternator Operation, maintenance & Spare parts Manual. ***(v)*** Alternator test certificate.

1.9. TESTS

a) The Diesel generator sets shall be tested for routine and acceptance tests as per the relevant IS/IEC standards.

b) The type test report for diesel engine and alternator are required as per relevant standard shall be submitted for purchaser's approval.In addition to the checks and test recommended by the manufacturer, the Contractor shall carryout the following commissioning tests to be carried out at site.

1. Load Test

The engine shall be given test run for a period of atleast 6 hours. The set shall be subjected to the maximum achievable load as decided by Purchaser without exceeding the specified DG Set rating :During the load test, half hourly records of the following shall be taken :

a) Ambient temperature.
b) Exhaust temperature if exhaust thermometer is fitted.
c) Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.
d) Lubricating oil temperature where oil cooler fitted.
e) Lubricating oil pressure.
f) Colour of exhaust gas
g) Speed
h) Voltage, wattage and current output.
i) Oil tank level

The necessary load to carryout the test shall be provided by the purchaser.

2. Insulation Resistance Test for Alternator

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500V megger shall not be less than IR=2x(rated voltage in KV)+1

3. Check of Fuel Consumption

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

4. Insulation Resistance of Wiring
   Insulation resistance of control panel wiring shall be checked by 500V Megger. The IR shall not be less than one mega ohm.
5. Functional Tests
   a) Functional tests on control panel.
   b) Functional test on starting provision on the engine.
   c) Functional tests on all Field devices.
   d) Functional tests on AVR and speed governor.
6. Measurement of Vibration
   The vibration shall be measured at load as close to maximum achievable load and shall not exceed 250microns.
7. Noise Level check as per relevant standard
8. The tests shall be carried out with the DG set operating at rated speed and at maximum achievable load. Necessary correction for Test environment condition & background noise will be applied as per IS:12065.

Control and monitoring of DG set shall be integrated in Substation Automation System.

SECTION: LT SWITCHGEAR

1.1. CONSTRUCTIONAL DETAILS OF SWITCH BOARDS AND DISTRIBUTION BOARDS

2 Nos 33 KV bays shall be constructed for station supply from tertiary of 315 MVA Auto transformers. Third source for station supply shall be from existing station transformer connected with 160 MVA auto transformer.

A new set of ACDB shall be supplied erected and commissioned in new control room building by the bidder to cater the entire AC load of 400/220/132 KV S/s Dhardehi. This ACDB shall get source from station transformer connected with 2 no. 315 MVA and 1 no. existing 160 MVA. The new AC supply shall be extended as source to existing ACDB of 220 S/s Dhardehi.

1.1.1. All boards shall be of metal enclosed, indoor floor mounted, compartmentalised construction and freestanding type.

1.1.2. All board frames, shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

1.1.3. All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

1.1.4. The complete structures shall be rigid, self-supporting, free from flaws, twists and bends.

All cut-outs shall be true in shape and devoid of sharp edges.

1.1.5. All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP: 52 as per IS ***13947 (Part-1).*** However, the busbar chambers having a degree of protection of IP: 42, in accordance with IS ***13947 (Part-1),*** are also acceptable where continuous busbar rating exceeds 1000 Amp. Provision shall be made in all compartments for providing IP: 52 degree of protection, when Circuit breaker or module trolley, has been removed. All cut-outs shall be provided with neoprene gaskets.

1.1.6. Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating exceeds 1000 Amps.

1.1.7. All boards shall be of uniform height not exceeding 2450 mm.

1.1.8. Boards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers.

1.1.9. Boards shall be supplied with base frames made of structural steel sections, alongwith all necessary mounting hardware required for welding the base frames to the insert plates.

1.1.10. All boards shall be ***of double front construction and shall have***

(i) A completely enclosed busbar compartment for running horizontal ***busbars*** and vertical busbars. Busbar chambers shall be completely enclosed with metallic portions. Bolted covers shall be provided for access to horizontal and Vertical busbars for repair and maintenance, which shall be feasible without disturbing feeder compartment. Vertical bus bar chambers shall be accessible from front as well as back side of the panel. One set of vertical busbars shall be used in between two adjacent sections for switchgear connections. In case of Incomer(s), Bus-coupler and ACB feeders, vertical busbars located in rear side shall be additionally covered with metallic

perforated bolted sheets to avoid direct access after opening rear door of chamber.

(ii) Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker or MCCB or motor starter.

(iii) A distinct compartment or alley for power and control cables on each side of panel. Cable alley compartment shall have a through metallic partition for segregating cables on both sides. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts. Any live terminals shall be fully shrouded/insulated from safety aspects. However It shall be of at least 350mm width.

(iv) A compartment for relays and other control devices associated with a circuit breaker.

1.1.11. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

1.1.12. All equipments associated with a single circuit except MCB circuits shall be housed in a separate compartment of the vertical section. The Compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. The front of the compartment shall be provided with the hinged single leaf door, with locking facilities.

In case of circuits controlled by MCBs, group of MCB feeders can be offered in common compartment. In such case number of MCB feeder to be used in a common compartment shall not exceed 4 (four) and front of MCB compartment, shall have a viewing port of toughen glass sheet for viewing and sheet steel door of module shall be lockable with star knob/panel key.

1.1.13. After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

1.1.14. The minimum clearance in air between phases and between phase and earth for the entire run of horizontal and vertical busbars, shall be 25 mm. For all other components, the clearance between "two live parts", " A live part and an earthed part" and isolating distance shall be atleast ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal run of busbar minimum clearance of 25 mm should be maintained even if they are sleeved.

1.1.15. The temperature rise of horizontal & vertical busbars when carrying rated current along its full run shall in no case exceed 55°C, with silver plated joints and 40°C with all other type of joints over an outside ambient temperature of 50°C.

1.1.16. All **busbar chambers** shall be provided with removable bolted covers. The covers shallbe provided with danger labels.

1.1.17. All identical circuit breakers and module chassis of same test size shall be interchangeable without having to carryout modifications.

1.1.18. All Circuit breaker boards shall be of Single Front type, with drawout circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position.

1.1.19. Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to

avoid accidental touch with the live parts of one circuit when working on the other circuit.

1.1.20. All disconnecting contacts for power circuits shall be of robust design and self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.

1.1.21. All AC & DC boards shall be of ***double*** Front type.

1.1.22. All module shall be fixed type except air circuit breaker module, which shall be drawout type.

1.1.23. The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

1.1.24. All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to PURCHASER approval. Bidder shall submit dimensional drawings showing complete internal details of Busbars and module components, for each type and rating for approval.

1.1.25. The tentative power and control cable entries shall be from bottom. However, Purchaser reserves the right to alter the cable entries, if required, during detailed engineering, without any additional commercial implication.

1.1.26. Adopter panels and dummy panels required to meet the various busbar arrangements andlayouts required shall be included in Bidder's scope of work.

1.3. POWER BUS BARS AND INSULATORS

1.3.1. All AC Distribution Boards shall be provided with three phase buses and a neutral busbars and the DC Distribution Boards shall be provided with two busbars.

1.3.2. All busbars and jumper connections shall be of high conductivity copper of adequate size the bus bar size calculation shall be submitted for approval.

1.3.5. All busbars joints shall be provided with high tensile steel bolts. Belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated Busbars joints shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

1.3.6. All busbars shall be colour coded as per IS: ***11353***

1.3.7. The Bidder shall furnish calculations alongwith the bid, establishing the adequacy of busbar sizes for specified current ratings, On the basis of short circuit current and temperature rise consideration at specified ambient temp.

1.4. EARTH BUS

1.4.1. A galvanised steel earthing shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded/bolted to the frame work of each panel and breaker earthing contact bar vertical bus shall be provided in each vertical section which shall in turn be bolted/welded to main horizontal ground bus.

1.4.2. The earth bus shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth as indicated in `Bill of Materials' without exceeding the allowable temperature rise.

1.4.3. Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Purchaser's earthing conductors. The horizontal earth bus shall project out the switchboard ends and shall have predrilled holes for this connection. A joint spaced and taps to earth bus shall be made through at least two bolts.

1.4.4. All non-current metal work of the Switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosures frame work and the truck shall be maintained even after painting.

1.4.5. The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions. SERVICES & ISOLATED, as well as through out the intermediate travel.

1.4.6. Each module frame shall get engaged to the vertical earth bus. Before the disconnectingcontacts on these module are engaged to the vertical busbar.

1.4.7. All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth by independent stranded copper wires of size not less than 2.5 mm2. Insulation colour code of earthing wires shall be green. Earthing wires shall beconnected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earth Connection which would result in loss of earth connection to the devices when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths or earth bus is acceptable.

1.4.8. VT and CT secondary neutral point earthing shall be at one place only.

1.5. **AIR CIRCUIT BREAKERS**

1.5.1. Circuit breakers shall be three-pole air break horizontal drawout type and shall have inherent fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.

1.5.2. Circuit breakers shall be mounted along with it operating mechanism on a wheeledcarriage. Suitable guides shall be provided to minimise misalignment of the breaker.

1.5.3. There shall be `Service', `Test' and `Fully withdrawn positions for the breakers. In `Test' position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power Contacts shall be disconnected while the Control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the `SERVICE', `TEST' OR FULLY WITHDRAWN' position. It shall be possible to close the door in TEST position.

1.5.4. All circuit breakers shall be provided with 4 NO and 4 NC potentially free spare auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both `SERVICE' & `TEST' position of the breaker. All contacts shall be rated for making continuously carrying and breaking 10 Amps at 240V AC and 1 Amp (Inductive) at 220V DC.

1.5.5. Suitable mechanical indications shall be provided on all circuit breakers to show `OPEN'. `CLOSE', `SERVICE', `TEST' and `SPRING CHARGED' positions.

1.5.6. Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.

1.5.7. All circuit breakers shall be provided with the interlocks as explained in further clauses.

1.5.8. Movement of a circuit breaker between SERVICE AND TEST positions shall not be possible unless it is in OPEN position. Attempted with drawl of a closed circuit breaker shall trip the circuit breaker.

1.5.9. Closing of a circuit breaker shall not be possible unless it is in SERVICE, TEST POSITION or in FULLY WITHDRAWN POSITION.

1.5.10. Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. It shall however, be possible to open the shutters intentionally, against spring pressure for testing purpose.

1.5.11. A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

1.5.12. Circuit breakers shall be provided with electrical anti-pumping and trip free feature, evenif mechanical antipumping feature is provided.

1.5.13. Mechanical tripping shall be possible by means of front mounted RED `Trip' push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

1.5.14. Breaker controlled motors shall operate satisfactorily under the following conditions:

(i) Direct on-line starting of Induction Motors rated 110 kW to 220 kW with a locked rotor current of seven times the rated current, and starting time of up to 30 seconds.

(ii) Breaking on-load, full load and locked rotor currents of Induction Motors for rated 100 kW to 220 kW.

1.5.15. Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of Contacts, in service position slow closing shall not be possible.

1.5.16. Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC Control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class `E' or better.

1.5.17. The motor shall be such that it requires not more than 30 seconds for charging the closing spring.

1.5.18. Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

1.5.19. The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

1.5.20. Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.

1.5.21. All circuit breakers shall be provided with closing and trip coils. The closing coils shall operate correctly at all values of Voltage between 85% to 110% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

1.5.23. **PROTECTION CO-ORDINATION**

1.5.23.1 It shall be the responsibility of the Contractor to co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and down stream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.**Control and monitoring of circuit Breakers shall be integrated into Substation Automation System. An independent BCU shall be provided for the same.**

1.6. MOULDED CASE CIRCUIT BREAKER (MCCB) and MCB

1.6.1. MCCB shall in general conform to IS: 13947 Part-2. All MCCB shall be of P2 duty.

1.6.2. MCCB shall be flush mounted on the AC/DC distribution boards.

1.6.3 MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protection. The setting of the thermal release shall be adjustable between 75% to 100% of the rated current. The MCCB shall have breaking capacity not less than 20kA.

1.6.4 MCCBs used for ACDB incomers and Bus coupler shall be equipped with stored energy mechanism for electrical closing and tripping. All other MCCBs shall be manually operated. The operating handle should give a clear trip indication.

1.6.5 Miniature circuit breaker (MCB) shall conform to IEC: 898-1987 and IS:8828.

1.6.6 All MCCBs and MCBs shall always be provided with HRC fuses of suitable rating.

1.7 RELAYS

1.7.1 All relays and timers in protective circuits shall be of Numerical Type and IEC61850 compatible. These are to be integrated in the Substation Automation System. The relays should be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a draw out construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases.

1.7.2 All AC relays shall be suitable for operation, at 50 Hz with 110 volts VT secondary and 1amp or 5 amp CT secondary and 220 v Dc aux supply.

1.7.3 All protective relays and timers shall have at least two potentially free spare output contacts.Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

1.7.4 All protective relays auxiliary relays and timers shall be provided with hand resetoperation indicators (Flags) for analysing the cause of operation.

1.7.5 All relays shall withstand a test voltage of 2 KV (rms) for one minute.

1.7.6 Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

1.7.7 All fuse-protected contactor-controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bimetallic strips), or as a separate device. The single phasing protection shall operate even with 80% of the set current flowing in two of the phases.

1.8 CONTACTORS

1.8.1 Motor starter contactors shall be of air break, electromagnetic type rated foruninterrupted duty as per IS:13947 (Part 4).

1.8.2 Contactors shall be double break, non-gravity type and their main contacts shall be silverfaced.

1.8.3 Direct on line starter contactors shall be of utilisation category AC2. These contactorsshall be as per IS:13947 (Part 4).

1.8.4 Each contactor shall be provided with two (2) normally open (NO) and two (2) normallyclose (NC) auxiliary contacts.

1.8.5 Operating coils of contactors shall be of 240V AC Unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall drop out at 70% of the rated voltage.

1.9 INSTRUMENT TRANSFORMERS

1.9.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

1.9.2 All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

1.9.3 All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

1.9.4 Current transformers may be multi or single core type. All voltage transformers shall besingle phase type. The Bus VTs shall be housed in a separate compartment.

1.9.5 All VTs shall have readily accessible HRC current limiting fuses on both primary andsecondary sides.

1.10 **INDICATING INSTRUMENTS**

1.10.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

1.10.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

1.10.3 All instruments shall have white dials with black numerals and lettering. Black knifeedge pointer with parallax free dials will be preferred.

1.10.4 Ammeters provided on Motor feeders shall have a compressed scale at the upper currentregion to cover the starting current.

1.10.5 Watt-hour meters shall be of 3 phase three element type, Maximum demand indicatorsneed not be provided.

1.11 **CONTROL & SELECTOR SWITCHES**

1.11.1 Control & Selector switches shall be of rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

1.11.2 Circuit breaker selector switches for breaker Controlled motor shall have three stay put positions marked `Switchgear', `Normal' and `Trial' respectively. They shall have two contacts of each of the three positions and shall have black shade handles.

1.11.3 Ammeter and voltmeter selector switches shall have four stayput position with adequate number of contacts for three phase 4 wire system. These shall have oval handles Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.

1.11.4 Contacts of the switches shall be spring assisted and shall be of suitable material to give along trouble free service.

1.11.5 The contact ratings shall be at least the following :

(i)	Make and carry continuously	10 Amp.
(ii)	Breaking current at 220V DC	1 Amp (Inductive)
(iii)	Breaking current at 240V AC	5 Amp (at 0.3 pf lagging)

1.12 **AIR BREAK SWITCHES**

1.12.1 Air breaker switch shall be of the heavy duty, single throw group operated, load break,fault make type complying with IS:4064.

1.12.2 The Bidder shall ensure that all switches are adequately rated so as to be protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

1.12.3 Switch operating handles shall be provided with padlocking facilities to lock them in`OFF' position.

1.12.4 Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in `OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

1.12.5 Switches and fuses for AC/DC control supply and heater supply wherever required shallbe mounted inside and cubicles.

1.13 **PUSH BUTTONS**

1.13.1 Push-buttons shall be of spring return, push to actuate type. Their contacts shall be ratedto make, continuously carry and break 10A at 240V and 0.5A (inductive) at 220V DC.

1.13.2 All push-buttons shall have one normally open and one normally closed contact, unlessspecified otherwise. The contact faces shall be of silver or silver alloy.

1.13.3 All push-buttons shall be provided with integral escutcheon plates marked with itsfunction.

The colour of the button shall be as follows :

1	GREEN	For motor START, Breaker CLOSE
2	RED	For motor TRIP, Breaker OPEN
3	BLACK	For overload reset.

1.13.5 All push-buttons on panels shall be located in such a way that Red-push-buttons shall always be to the left of green push-buttons.

1.14 **INDICATING LAMPS**

1.14.1 Indicating lamps shall be of the panel mounting cluster LED type.

1.14.2 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

I	RED	For motor ON, Breaker CLOSED
II	GREEN	For motor OFF, Breaker OPEN
III	WHITE	For motor Auto-Trip
IV	BLUE	For all healthy conditions (e.g. control supply, and also for
		'SPRING CHARGED"
V	AMBER	For all alarm conditions (e.g. overload) Also for
		`SERVICE' and `TEST' positions indicators.

1.14.3 Lamps shall be easily replaceable from the front of the cubicle.

1.14.4 Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and Amber lamps should normally be located above the Red and Green lamps.

1.14.5 When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

1.15 **FUSES**

1.15.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC Circuits shall be of class 2 type, 20 kA (RMS) breaking current at 415 AC, and for DC circuits Class 1 type 4 kA breaking current.

1.15.2 Fuses shall have visible operation indicators.

1.15.3 Fuses shall be mounted on fuses carriers, which are mounted on fuse bases, wherever it is not possible to mount fuses on carriers fuses shall be directly mounted on plug in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

1.15.4 Fuse rating shall be chosen by the Bidder depending upon the circuit requirements and these shall be subject to approval of PURCHASER. HRC fuses shall be used in series with MCBs and MCCBs.

1.16 **TERMINAL BLOCKS**

1.16.1 Terminal blocks shall be of Stud type and of 1100 volts grade and have continuous rating to carry the maximum expected current on the terminals. It shall be complete with insulating barriers, clip-on-type/stud type terminals for Control Cables and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring on diagrams.

1.16.2 Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities.

1.16.3 In all circuit breaker panels at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.

1.16.4 All terminal blocks shall be suitable for terminating on each side, two (2) Nos. of 2.5 mmsquare size standard copper conductors.

1.16.5 All terminals shall be numbered for identification and grouped according to the function.

Engraved white-on-black labels shall be provided on the terminal blocks.

1.16.6 Wherever duplication of a terminal block is necessary it shall be achieved by solidbonding links.

1.16.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal block and the associated cable gland plate shall be 250 mm.

1.19 **CONTROL AND SECONDARY WIRING**

1.19.1 All switchboards shall be supplied completely wired internally upto the terminal blocksready to receive Purchaser's control cables.

1.19.2 All inter cubicle and inter panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the bidder.

1.19.3 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour coded, PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires. Voltage grade and insulation shall be same as above.

1.19.4 Extra-flexible wires shall be used for wiring to device mounted on moving parts such ashinged doors.

1.19.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminals blocks.

1.20 **POWER CABLES TERMINATION**

1.20.1 Cable termination compartment and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured XLPE/PVC insulated and sheathed, single core/three core, 1100 V grade cables.

1.20.2 All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the successful bidder, to suit the final cable sizes which would be advised later.

1.20.3 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory-drilled according to the cable gland sizes and number which shall be informed to the Contractor later. For all single core cables, gland plates shall be of non-magnetic Material.

1.21 **TYPE TESTS**

1.21.1 Type tests reports on Panels (Switchgear and Control gear assemblies) as per IS 8623 Part-I shall be submitted for the following tests in line with clause 9.0 of Section GTR before the fabrication of switchgear is started:

i) Verification of temperature rise limits
ii) Verification of the dielectric properties
iii) Verification of short circuit strength
iv) Verification of the continuity of the protective circuit
v) Verification of clearances and creepage distances
vi) Verification of mechanical operation
vii) Verification of degree of protection

1.21.2 Contractor shall submit type test reports for the following Switchgear and Control gearsbefore the fabrication of switchgear is started:

1. Circuit breakers/MCCB as per IS 13947 Part-II
2. Protective Relays as per IEC: 60255

For above equipments, test conducted once are acceptable (i.e. The requirement of test conducted within last five years shall not be applicable)

1.22 ERECTION, TESTING AND COMMISSIONING

1.22.1 The Contractor shall unload, erect, install, test and put into commercial use all electricalequipment included in this specification.

1.22.2 Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in Contractor's drawings or as stipulated by purchaser. No equipment shall be permanently bolted down to foundations until the alignment has been checked and found acceptable by the purchaser.

1.22.3 Contractor shall furnish all supervision, labour tools equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time required to completely install, test and commission the equipment.**The contractor shall ensure that the required minimum number of engineering/supervisory and skilled personnel are engaged as given in Annex. Also the required minimum T & P as stipulated in the Annex shall be employed.**

1.22.**4** **Manufacturer's and purchaser's instructions and recommendations shall be correctlyfollowed in handling, setting, testing andcommissioning of all equipment**.

1.22.5 Contractor shall move all equipment into the respective room through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilised to lift or erect any equipment without prior permission of Purchaser.

1.22.6 All boards shall be installed in accordance with Indian Standards IS:3072 and at Purchaser's instructions. All boards shall be installed on finished surfaces, concrete or steel stills. Contractor shall be required to install and align any channel sills which form part of foundations. In joining shipping sections of switchboards together adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has been completed. Power bus, enclosures ground and control splices of conventional nature shall be cleaned and bolted together being drawn up with torque spanner of proper size or by other approved means.

1.22.7 All boards shall be made completely vermin proof.

1.22.8 Contractor shall take utmost care in holding instruments, relaying and other delicate mechanism wherever the instruments and relays are supplied separately they shall be mentioned only after the associated panels have been erected and aligned. The packing materials employed for safe transit of instrument and relays shall be removed after ensuring that panel have been completely installed and to further movement of

the same should be necessary. Any damage shall be immediately reported to Purchaser.

1.22.9 Equipment furnished with finished coats of paint shall be touched by up Contractor iftheir surface is specified or marred while handling.

1.22.10 After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards/panels and correctness of all equipment in each and every respect. The cable opening and cables entries for cables terminating to the panels shall be sealed with fire sealing materials.

1.23 COMMISSIONING CHECK TESTS

The Contractor shall carry out the checks as per the check list provided by the manufacturer's instructions manual. Additionally, following commissioning checks, in addition to the other checks and tests recommended by the manufacturers shall be carried out. The manufacturer shall provide a copy of all the relevant approved drawings/manuals of all the equipments to the Engineer In Charge before the start of erection work.

1.23.1 General

1.23.1.1 Check name plate details according to the specification.
1.23.1.2 Check for physical damage.
1.23.1.3 Check tightness of all bolts, clamps, joints connecting terminals.
1.23.1.4 Check earth connection.
1.23.1.5 Check cleanliness of insulators and bushings.
1.23.1.6 Check all moving parts for proper lubrication.
1.23.1.7 Check settings of all the relays.

1.23.2 Circuit Breakers

1.23.2.1 Check alignment of breaker truck for free movement.
1.23.2.2 Check correct operation of shutters.
1.23.2.3 Check control wiring for correctness of connections, continuity and IR values.
1.23.2.4 Manual operation of breaker completely assembled.
1.23.2.5 Power closing/opening operation, manually and electrically.
1.23.2.6 Breaker closing and tripping time.
1.23.2.7 Trip free and anti-pumping operation. Pole discrepancy check
1.23.2.8 IR values, minimum pick up voltage and resistance of coils.
1.23.2.9 Contact resistance, dynamic contact resistance measurement.
1.23.2.10 Simultaneous closing of all the three phases. Auto reclosure functions
1.23.2.11 Check electrical & mechanical interlocks provided.
1.23.2.12 Check on spring charging motor, correct operation of limit switches, and time ofcharging.
1.23.2.13 All functional checks.

1.23.3 Current Transformers

1.23.3.1 Megger between winding and winding terminals to body.
1.23.3.2 Polarity test
1.23.3.3 Ratio identification checking of all ratios on all cores by primary injection of current. CT wiring checking with primary current injection method.
1.23.3.4 Spare CT cores, if available, to be shorted and earthed, tan delta test point earthed.

1.23.4 Voltage Transformer

1.23.4.1 Insulation resistance test
1.23.4.2 Ratio test on all cores.
1.23.4.3 Polarity test.
1.23.4.4 Line connections as per connection diagram.

1.23.5 **Cubicle Wiring**

1.23.5.1 Check all switch developments.

1.23.5.2 Each wire shall be traced by continuity tests and it should be made sure that thewiringis as per relevant drawing. All interconnections between panels/equipmentshallbe similarly checked.

1.23.5.3 All the wires shall be meggered to earth.

1.23.5.4 Functional checking of all control circuit e.g. closing, tripping control, interlock, supervision and alarm circuit.

1.23.6 **Relays**

1.23.6.1 Check connections and wiring.

1.23.6.2 Megger all terminals to body.

1.23.6.3 Megger AC to DC terminals.

1.23.6.4 Check operating characteristics by secondary injection.

1.23.6.5 Check minimum pick up voltage of DC coils.

1.23.6.6 Check operation of electrical/mechanical targets.

1.23.6.7 Relays settings. Various extensive tests for all the settings parameters and functional tests

1.23.6.8 Check CT and VT connections with particular reference to their polarities for directionalrelays, wherever required.

1.23.7 **Meters**

1.23.7.1 Check calibration by comparing it with an Electronic sub-standard meter.

1.23.7.2 Megger all insulated portions.

1.23.7.3 Check CT and VT connections with particular reference to their polarities for power type meters.

1.24 **SPECIAL TOOLS AND TACKLES**

1.24.1 The list of these special tools and tackles shall be given in the bid proposal sheetsalongwith their respective prices.

1.24.2 The total price of the special tools and tackles shall be included in proposal sheets.

1.25 **OTHER EQUIPMENTS**

1.25.1 The Bidder shall quote for various AC/DC distribution boards in accordance with this specification and LT SLD provided in this tender.

1.25.2 Standard scheme of interconnection of switchboards and distribution boards alongwith tentative feeder disposition for each board is indicated in Standard SLD of AC & DC system enclosed along with bid documents. The bidder shall quote board prices on the basis of standard SLD and their estimation of feeders for entire present and future bays requirement. Any other feeder required as per system requirement for efficient and reliable operation shall be deemed to be included in bidder's scope.**The control and monitoring of Auxiliary LT system shall be integrated into the Substation Automation System. Necessary quantity of Bay controller Units shall be provided by the contractor for the purpose of integration of control and monitoring of LT system. The design and architecture of the same shall be got approved. Redundancy in control circuit shall be ensured.**

1.25.3 The Bill of Materials for each type of module shall be as under. These are minimum indicative requirement of the system. The necessary auxiliary relays, push buttons and indicating lamps shall be provided as per scheme requirement. Any other item/component required with in a module for efficient and reliable operation shall be deemed to be included in bidder's scope. The scheme shall have provision for remote annunciation for the followings:

a) Station LT (41 5V) AC incomer supply unhealthy
b) 220V DCDB U/V, O/V & Earth leakage relay operated
c) 48V DCDB U/V & O/V relay operated

d) DG set start
e) DG set protection operated.

1.25.4 Module Type AE (Electrically controlled circuit breaker for incoming and Bus Coupler Circuit).

(i)	One (1)	Triple pole air circuit breaker complete with all accessories andpower operated mechanism as specified.
(ii)	Two (2)	Neutral link.
(iii)	Three (3)	Current Transformer for metering.
(iv)	One (1)	Ammeter with selector switch.
(v)	Three (3)	Current Transformer for relaying.
(vi)	One (1)	Triple pole instantaneous over-current relay having thesetting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time.
(vii)	One (1)	Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 80% of CT secondary current and adjustable definite minimum time. The earth fault relay shall be provided with a stabilising resistor.

1.25.5 **Module Type - M1 (Circuit Breaker Controlled Motor Feeder)**

(i)	One (1)	Triple pole Air Circuit Breaker complete with accessories,and power operated mechanism as specified.
(ii)	One (1)	Three position 6 pole selector switch 'SWITCHGEAR/NORMAL /TRIAL'.
(iii)	Three (3)	Current Transformer for metering.
(iv)	One (1)	Ammeter with Ammeter Selector Switch
(v)	Three (3)	Current Transformer for relaying.
(vi)	One (1)	Triple pole instantaneous over-current relay for providingpositive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as required.
(vii)	One (1)	Double pole inverse definite minimum time over currentrelays connected in R & B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT Secondary current and time setting range of 0-30 Second. The relay shall be CDGM-22 of EE or equivalent.
(viii)	One (1)	Single pole adjustable definite time delay relay for motoroverload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously adjustable time delay range of 2.5 to 25 Sec.
(ix)	One (1)	Instantaneous earth fault relay having an adjustable settingrange of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.

1.25.6 **Module Type E**

(i)	One (1)	Four pole MCCB

1.25.7 **Module G-1 (VT Module with under Voltage Relay)**

(i)	Three (3)	415 /√3/110/√3 volts single phase voltage transformer star/star connect with star point solidly earthed mounted on common

draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA Burden.

(ii)	Six (6)	HRC Fuses mounted on the above chassis.
(iii)	One (1)	Four position voltmeter selector switch.
(iv)	One (1)	Voltmeter (0-500V)
(v)	One (1)	Double pole instantaneous under voltage relays withcontinuous variable setting range of 40-80% of 110 Volts.
(vi)	One (1)	Time delay pick up relay having a time setting range of 0.5to 3 secs. with 3 `NO'. Self reset contacts, suitable for 220V DC.
(vii)	One (1)	Auxiliary relay 220V DC with 2 NO. self reset contacts.
(viii)	Three (3)	Indicating lamps with series resistor and colour lenses (Red,Blue & Yellow).

1.25.8 **Module Type G-2**

(i)	Three (3)	HRC Fuse
(ii)	One (1)	Voltmeter (0-500V)
(iii)	One (1)	Voltmeter selector switch four position (R-Y, Y-B, B-ROFF).
(iv)	Three (3)	Indication lamps (Red, Blue & Yellow)

1.25.9 **Module Type H & H (BC) (Isolating Switch Controlled Incoming Circuit)**

(i)	One (1)	Four pole MCCB
(ii)	One (1)	Red Indicating lamp to indicate isolating switch closedposition.

1.25.10 **Module Type S : (DC Metering and Protection Module)**

(i)	One (1)	Voltmeter 300-0-300V DC for 220V DC DB/Voltmeter 0-75V DC for 48V DCDB
(ii)	One (1)	Three (3) position voltmeter selector switch
(iii)	One (1)	Instantaneous under voltage relay with 95% of 220V DC.The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage.
(iv)	One (1)	Instantaneous over voltage relay with setting range of 110%of 220V DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series of resetting the relay at about 95% of the operating voltage.
(v)	One (1)	Earth leakage relay only for 220V DC system havingadjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/240V AC Auxiliary supply.

1.25.11 **Module Type X**

(i)	One (1)	Double pole 250 V MCB

1.25.12 **Module Type-DC (Incomer from Battery & Chargers)**

(i)	One (1)	Double pole 250V DC MCCB for incomer from Battery.
(ii)	One (1)	DC ammeter with shunt and range of 90-0-400 Amps. For220V DC DB and 90-0-200 Amp for 48V DC DB.
(iii)	Two (2)	Double pole 250V DC MCCB/MCB
(iv)	One (1)	Double pole single throw 250V DC air break switchconnecting battery & charger sections to DC DB.

1.25.13 **Module Type DG-1 (Electrically Controlled Circuit Breaker for Incomer from DGSet)**

a)	One (1)	Triple pole circuit breaker complete with all accessories and power operated mechanism as specified.
b)	One (1)	Frequency meter.
c)	One (1)	Voltmeter with selector switch.
d)	One (1)	Remote/Local Selector switch.
e)	Three (3)	Current transformer for metering.
f)	Six (6)	Current Transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel).
g)	Three (3)	Current transformer for relaying.
h)	One (1)	Ammeter Selector Switch.
i)	One (1)	Ammeter
j)	One (1)	Wattmeter of range 0-300 KW.
k)	One (1)	Three pole voltage controlled definite time delay relayhaving current setting range of 5 0-200% of CT secondary current and adjustable time delay 0.3 to 3 secs.
l)	One (1)	Watt hour meter with six (6) digits and minimum count ofone (1) kwh.
m)	One (1)	Single pole definite time over current relay having acontinuous setting range of 5 0-200% of CT secondary current and a time delay of 2.5-25 secs connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%.
n)	One (1)	Three pole differential protection relay having an operatingcurrent setting range of 10-40% of generator full load current. The relay shall be of high impedance type, with necessary stabilizing resistors.
o)	Two (2)	Push buttons for Remote starting & stopping of DG Set (Red,Green).

1.25.14 **Module Type H1**

(i)	One (1)	Double pole DC Switch with pad locking facility in off position.

1.25.15 **Module Type EL**

(i)	One (1)	Four pole MCCB
(ii)	One (1)	Contactor
(iii)		Electronic Timer suitable for continuous operation, push button and selectorswitch be as per scheme requirement

1.26 **PARAMETERS**

1.26.1 **Power Supply**

1.26.1.1	AC System	3 phase, 4 wire, solidly earthed
	a) Voltage	415 Volts, ± 10%
	Frequency Combined variation b) Fault Level	50 Hz ± 5% ± 10% Absolute Sum in Voltage & frequency 20 kA (rms)
1.26.1.2	**DC System**	2 Wire, unearthed
	a) System voltage	220V ± 10%
	b) Fault Level	4 kA
	c) System	48V ± 10%
	Voltage	
1.26.2	**Control Supply Voltage**	

	a) Trip and closing coils	220V DC Unearthed
	b) Spring charging	220V DC Unearthed
1.26.3	**Cubicle Data**	
1.26.3.1	**Busbar Rating**	

a) Continuous for Vertical panels. — As specified in `Bill of Materials'
b) Short time (1 sec.20 kArms)
c) Momentary 45 kAPEAK
d) **Ambient Temperature** — **50°C**
e) **One Minute Power Frequency Withstand**
I. Power Circuit — 2500 Volts (rms)
II. Control Circuit — 2500 Volts (rms)

1.26.3.2 **Cubicle Colour Finish**

a) Interior — Smoke Grey shade No.692 of IS:5
b) Exterior — Smoke Grey shade No.692 of IS:5

1.26.4 **Circuit Breaker**

a) Type — Air Break
b) No. of poles — 3
c) Voltage & Frequency — 415 ± 10%, 50 HZ + 5%
d) Rated Operating Duty — As per IS
e) Rated service short-circuit (RMS) Breaking capacity (Ics) — 20 kA
f) Short Circuit making current — 45 kA (Peak)
g) Short time withstand for 1 sec.current for 1 sec. duration. — 20 kA (RMS)
h) Operating Mechanism for 1 sec. current for 1 sec. duration. — 20 kA (RMS)
i) No. of auxiliary contacts — 4 NO & 4 NC contacts for Purchaser's use on fixed portion of the cubicle
j) Short Circuit breaking current
I. AC Component — 20 kA (RMS)
II. DC Component — As per IS: 13947 (Part 2)

1.26.5 **MOULDED CASE CIRCUIT BREAKER**

	AC System	DC System
a) No. of poles	42	
b) Voltage & Frequency	415 ± 10%,50 HZ + 5%	
c) Rated Operating Duty	As per IS	
d) Rated service short-circuit Breaking capacity (Ics)	20 kA (RMS)	4 kA
e) Short Circuit making current	45 kA (Peak)	-
f) No. of auxiliary	2 NO & 2 NC	2NO & 2NC

contacts

g) Short Circuit breaking current

I. AC Component	20 kA (RMS) As per IS	
II. DC Component	As per IS 13947	As per IS 13947

1.26.6 **Meters**

a)	Accuracy class	0.2
b)	One minute power frequency withstand test voltage in KV	2.0

1.26.7 **Current Transformers**

a)	Type	Cast resin, Bar primary
b)	Voltage class and frequency	650V, 50 Hz
c)	Class of Insulation	E or better
d)	Accuracy class metering CT	Class 1, VA adequate for application but not less than 7.5 VA.
e)	Accuracy class protection CT	5 P 15, VA adequate for application, but not less than 7.5 VA.
f)	Accuracy class differentialprotection	PS, KPV = 300V

g) Short Time Current Rating (for CTs Associated with circuit breakers)

I.	Current	20 kA (RMS)
II.	Duration	One Second
III.	Dynamic Rating	45 kA (Peak)
IV.	One minute power frequency withstand test voltage.	2.5 kV (rms)

1.26.8 **Voltage Transformer**

a)	Type	Cast Resin
b)	Rated Voltage	
	Primary	415/√3 V
	Secondary	11 0/√3 V
c)	Method of connection	
	Primary	Star
	Secondary	Star
d)	Rated voltage factor	1.1 continuous, 1.5 for 3 seconds
e)	Class of insulation	E or better
f)	One minute power frequency withstand voltage	2.5 KV (RMS)
g)	Accuracy class	0.5, not less than 20VA

1.26.9 **Relay**

One minute power frequency withstand test	2 kV (rms)

1.27 AUTOMATIC CONTROL OF OUTDOOR LIGHTING

1.27.1 EL-type module of 415V Main lighting distribution board and Emergency lighting distribution board and shall be controlled by timer and contactor module to facilitate its operation automatically.

1.28 AUTOMATIC SUPPLY CHANGEOVER

Automatic changeover between Incomer I, Incomer II,Incomer III supply (station transformer of 160 MVA transformer) and DG set is to be carried out during the failure of supply in one/or other incomers. The LT SLD has been provided with the tender. After the restoration of the supply, system shall be restored to normal condition automatically. The requirement of change over under various conditions are as below:

(i) Under normal conditions i.e. when supply is available in both the incomers, incomers I&II of 415 V Main switchboard, ACDB shall be in closed condition and Bus couplers , Incomer III and DG set breaker shall be in open condition.

(ii) In case of failure of either of the sources, the incomer of that source shall trip and Bus-coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.

iii) In case of failure of supply of all AC sources, ACDB Bus coupler shall trip and DG set breaker to be switched on. On restoration of one or all sources, DG set breaker shall trip, DG set stopped and conditions described in paragraph (i) /(ii) shall be restored.

To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be initiated after a time delay, after the conditions warranting such change has been detected.

TESTING INSTRUMENTS:

The special testing instrument and T & P as detailed below shall be covered under performance guarantee of three Years as mentioned against each of such Instrument therein.

Special Test Instruments

1. Transformer Diagonistic test set with capacitance and Tan delta measurement Model OMICRON CPC 100 – Multipurpose Primary Injection Test Kit with 2000A Current Booster and Test Cards included for testing Transformers, CTs & VTs, resistance and PRIMARY TEST MANAGER (PTM). OMICRON CPTD1 – Automatic Tan Delta & Capacitance Measurement system up to 12 kV with operating/Data Extraction/Analysis Device (With three year performance Guarantee)
2. 5 KV Insulation Tester (0-100000Mohm) make Vanguard /10/5KV Megger make/Tinsley(With three year performance Guarantee)
3. Micro processor based BDV of oil testing kit(Automatic 0-100KV) Deltronic Model: Portatest/ Baur DTA 100C – Oil Tester for Breakdown Voltage up to 100 kV, AVO/ Megger (With three year performance Guarantee)
4. Freja/Meggar/OMICRON– Three Phase Automatic Relay Test Kit with Over Current, Advance Distance & Advance Differential and advance Translay Software with Operating/Data Extraction/Analysis Device (With three year performance Guarantee)
5. Doble/Meggar/OMICRON make Sweep Frequency Response Analyzer for Testing Mechanical Integrity of Power Transformers with Operating/Data Extraction/Analysis Device. (With three year performance Guarantee)
6. Baur DTL C – Oil Tester for Dissipation Factor, Specific Resistance & Relative Permittivity. (With three year performance Guarantee)
7. Baur KFM3000 – Fully Automatic Water Content Measuring System. (With three year performance Guarantee)
8. Complete set of Circuit breaker analyzer kit ULTIMA HISAC of SCOPE make having 24 Channel, (four main + four PIR for three poles simultaneously, 8 auxiliary channels , three coil currents, three voltage channels for travel characteristic, DCRM, 12 analog channels for DCRM , Set of Transducers,100 A inbuilt DC source, Operating/Data Extraction/Analysis Device with operating software interface. (With three year performance Guarantee)
9. Winding Resistance Measurement Test Kit Make Vanguard , Type WRM - 40. (With three year performance Guarantee)
10. Thermovision camera Make Fluke/FLIR (With three year performance Guarantee)
11. Specifications for Operating/Data Extraction/Analysis Device :
    a) Necessary software and hardware to up load /down load the data to/from the relay from/to the Data Extraction Device.
    b) Operating/Data Extraction/Analysis Device having following specifications or better; Powered by 5th Generation Intel® Core i5-5200U Processor with Windows 8.1 Single Language (64Bit) English, RAM - 8GB Dual Channel DDR3L 1600 MHz (4GBx2), Hard Drive - 1TB 5400 rpm, Display : 15.6-inch HD (1366 x 768) Truelife LED-Backlit Touch Display, Video card : AMD Radeon™ R7 M270 4GB DDR3,Ports/slots-USB 3.0 with Power Share (1), USB 3.0 (1), USB 2.0 (1) HDMI™ v1.4a, Combination headphone/ microphone jack Noble Lock Slot AC Power In,

Multi-media Card Reader - Digital (SD) Memory Card, Secure Digital High Capacity (SDHC), Secure Digital Extended Capacity (SDXC), Power - Prismatic (58 WHr) Lithium Ion, Security Software-McAfee® Security Center 15 month subscription, Warranty - 1Yr ProSupport: Next Business Day Onsite Service w/ Accidental Damage

SECTION : POWER AND CONTROL CABLES

1. 1.1 KV GRADE POWER & CONTROL CABLES:

2. CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. transformers to control room, between distribution boards and for supply for colony lighting from control room.

Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.

For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5sqmm size with stranded Copper conductors having numbered cores shall be used.

The following table showing the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows –

S.N.	From	To	Cable size	Cable type
1	Main Switch Board	LT Transformer	1C X 630mm2 per phase 1C X 450 mm2 for neutral	XLPE
2	Main Switch Board	AC Distribution Board	1C X 300mm2 per phase	XLPE
3	Main Switch Board	Air Conditioning Board	1-3½C X 300mm2	XLPE
4	Main Switch Board	Oil Filtration unit	1-3½C X 300mm2	XLPE
5	Main Switch Board	Colony light	1-3½C X 300mm2	XLPE
6	Main Switch Board	HVW pump LCP	1-3½C X 300mm2	XLPE
7	Main Switch Board	Lighting X'mer	1-3½C X 300mm2	XLPE
8	Lighting transformer	Main lighting distribution Board	1-3½C X 300mm2	XLPE
9	AC Distribution Board	DG set AMF panel	2-3½C X 300mm2	XLPE
10	AC Distribution Board	Emergency lighting X'mer	1-3½C X 70mm2	PVC
11	Emergency lighting X'mer	Emergency lighting DB	1-3½C X 70mm2	PVC
12	AC Distribution Board	ICT MB	1-3½C X 70mm2	PVC
13	AC Distribution Board	Bay MB	1-3½C X 35mm2	PVC
14	AC Distribution Board	Battery charger	1-3½C X 70mm2	PVC
15	DCDB	Battery	2-1C X 100mm2	PVC
16	DCDB	Battery Charger	2-1C X 100mm2	PVC
17	DCDB	Protection	1-2C X 6mm2	PVC
18	Main lighting DB	Lighting panels (Indoor)	1-3½C X 35mm2	PVC
19	Main lighting DB	Lighting panels (Indoor)	1-3½C X 70mm2	PVC
20	Main lighting DB	Lighting panels (Indoor)	1-3½C X 35mm2	PVC
21	Main lighting DB	Lighting panels (Indoor)	1-3½C X 70mm2	PVC

22	Lighting panel	Sub lighting panels	1-4C X 16mm2	PVC
23	Lighting panel	Street lighting pole	1-4C X 16mm2	PVC
24	Lighting panel/Sub lighting panel	Lighting fixtures (Outdoor)	1-2C X 6mm2	PVC
25	Bay MB	Equipments	1-4C X 16mm2 1-4C X 6mm2 1-2C X 6mm2	PVC
26	Air conditioning Board	A/C unit panel	1-3½C X 70mm2	PVC
27	Air conditioning Board	AHU	1-3½C X 70mm2	PVC
28	Air conditioning Board	Heater	1-3½C X 35mm2	PVC
29	Air conditioning Board	Chiller pump	1-3½C X 35mm2	PVC

Cables shall be laid conforming to IS:1255.
Separate cables shall be used for AC & DC.
For control cabling, including CT/VT circuits, 6sqmm size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used.

4. CABLE DRUMS

4.1 Cables shall be supplied in **returnable** wooden/ steel drums of heavyconstruction. Wooden drum shall be properly seasoned sound and free from defects. Wooden preservative shall be applied to the entire drum.

4.2 Standard lengths for each size of power and control cable shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. **Maximum, One (1) number nonstandard length of cable size (s) may be supplied in drums for completion of project.**

4.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

4.4 A clear space of at last 40 mm shall be left between the cables and the lagging.

4.5 Each drums shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

4.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Bothe cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

5 TYPE TESTS

5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

5.2.1 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V:-

5.2.1 Following type tests**(on one size in a contract)**as per IS: 7098 (Part 1)-1988 including its amendments shall be carried out **as a part of acceptance tests** on XLPE insulated power **cables for working voltages up to and including 1100V:**

a) Physical tests for insulation
   i) Hot set test
   ii) Shrinkage test
b) Physical tests for outer sheath
   i) Shrinkage test
   ii) Hot deformation
   iii) Heat shock test
   iv) Thermal stability

5.2.2 **Contractor shall submit type test reports as per clause no.9.2 of Technical Specification, Section: GTR for the following tests:-**

a) Water absorption (gravimetric) test.
b) Ageing in air oven
c) Loss of mass in air over
d) Short time current test on power cables of sizes 240 sqmm and above on
   i) Conductors.
   ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test.

5.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-

5.3.1 Following type tests (**on one size in a contract**)as per IS: 1554(Part 1)- 1988 its amendments shall be carried out as **a part of acceptance tests** on PVC insulated **power & control cablesfor working voltages up to and including 1100 v :**

a) Physical test for insulation and outer sheath
   i) Shrinkage test
   ii) Hot deformation
   iii) Heat shock test
   iv)Thermal stability
b) High voltage test (water immersion test only a.c. test as per clause no. 16.03.01).

5.3.2 **Contractor shall submit type test reports for the following-**

a) High voltage test (water immersion d.c.test as per clause no.16.3.2 of IS: 1554(Part 1)- 1988).
b) Ageing in air oven.
c) Loss of mass in air oven**.**
d) Short time current test on power cables of sizes 240 sqmm and above on
   i) Conductors.
   ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test

STANDARD TECHNICAL DATA SHEET
(1.1 KV GRADE XLPE POWER CABLES)

Sl.No.	CUSTOMER :	CSPTCL Raipur
	Name of Manufacturer :	
	Cable Sizes	1 C x 630 3½ C x 300
1	Manufacturer's type designation	A²xwy A²xwy
2	Applicable standard	----------IS:7098/PT-V1988 its referred specifications----------
3	Rated Voltage(volts)	1100 Vgrad
4	Type & category	FR AND C1
5	Suitable for earthed or unearthed system	For both
6	Continuous current rating when laid in air in a ambient tem. of 50ºC and for maximum conductor temp. of 70ºC of PVC Cables (for information only)	732 . 410
7	Rating factors applicable to the current ratings for various conditions of installation:	As per IS :3961 Part II- 67
8	Short circuit capacity	
	a) Guaranteed short circuit Amp.(rms) K.A. for 0.12 sec .duration at raled conductor temperature of 90ºC with an initial pack of 105 KA.	45 kA 45 kA
	B)Maximum Conductor temperature allowed for short circuit duly (deg.) c) As stated above.	250ºC
9	Conductor	
	a) Material	Stranded Aluminium as per class 2 of IS :8730
	b) Grade	H2(Electrolytic grade)
	c) Cross section area (sq.mm.)	630 300/150
	d)Number of wires (No.)minimum	53 30/15
	e) Form of conductor	Stranded and Stranded compacted circular compacted
	f) Direction of lay of stranded layers	Outmost tayer shall be R.H.lay & opposite in successive lyers
10	Conductor resistance(dc) at20ºC per km –maximum	.0469 .1/.206
11	Insulation	
	a) Composition of insulator	Extruded XLPE as per IS:7098
	b)Nominal thickness of insulation (mm)	2.8 1.8/1.4
	c) Minimum thickness of insulation	2.42 1.52/1.16
12	Inner Sheath	
	a) Material	Extruded PBC Type ST-2 as per IS :5831 34
	b) Calculated diameter over the laid up cores(mm)	NA 52
	c)Thickness of sheath (minimum)mm	NA 0.6

	d) Method of extrusion	NA Pressure /Vacuum extrusion
13	Armour	
	a) Type and material of armour	Alum.Wire (H4 grad) Gal Steel Wire
	b)Direction of armouring	Left Hand
	c) Calculated diameter of cable over inner sheath (under armour),mm	33.9 53.2
	d)Nominal diameter of round armour wire(minimum)	2 2.5
	e) Guranteed short circuit of the arnour for 0.12 sec at room temperature.	45kA 45kA
	f) D.O. resistance at 20ºC (km)	5 .577
14	Outer sheath	
	a) Material (PVC Type)	ST-2 and FR ST-2and FR
	b) Calculated diameter under the sheath	38.3 59.5
	c) Min. thickness of sheath(mm)	1.72 2.36
	d) Guaranteed value of minimum oxygen index of outey sheath at 270ºC	Min. 29 Min. 29
	e) Guranteed value of minimum temperature index at 21 oxygen index	Min. 250 Min. 250
	f) colour os sheath	Black Black
15	a) Nominal Overall diameter o cable	5 5
	b) Tolerance on overall diameter (mm)	+21/ -2
16	Cable Drums	Shall confirm toIS :10418 and technical spec
	a) Max standard length per drum for each size of cable (single length)with 25% Tolerance(mtrs)	1000/500 1000/500
	b) Non standard drum lengths	Max.1 Non standard length of each cable size may be supplied in drums only over and above the standard length
17	Whether progressive sequential marking on sheath provided at 1 meter interval	Yes
18	Identification of cores	
	a) colour of cores	As per IS :7098
	b) Numbering	NA
19	Whether cables offered are ISI marked	Yes
20	Whether cables offered are suitable for laying as per IS 1255	Yes

STANDARD TECHNICAL DATA SHEET
(1.1 KV GRADE XLPE POWER CABLES)

Sl. No.	CUSTOMER :	CSPTCL Raipur
	Name of Manufacturer :	As per approved list
	Cable Sizes	1 C x 150 3.5 Cx70 3.Cx3.5 4x16 4Cx6 2 Cx6
1	Manufacturer's type designation	AYWay AYFY AYFY AYFY AYWY AYWY
2	Applicable standard	IS:1554/PT-1/198 &its referred standards
3	Rated Voltage(volts)	1100 Vgrade
4	Type & category	FR &C1 FR &C1 FR&C1 FR&C1 FR&C1 FR&C1
5	Suitable for earthed or unearthed system	For both
6	Continuous current rating when laid in air in a ambient tem. of 50ºC and for maximum conductor temp. of 70ºC of PVC Cables (for information only)	202 105 70 41 24 28
7	Rating factors applicable to the current ratings for various conditions of installation:	As per IS :3961 Part II- 67
8	Short circuit capacity	
	a) Short circuit Amp(ms) KA for 1 sec duration.	11.2 5.22 2.61 1.19 0.448 0.448
	b) conductor temp. allowed for the short circuit duty (deg c)	160ºC
9	Conductor	
	a) Material	Stranded Aluminium
	b) Grade	H2(Electrolytic grade)
	c) Cross section area (sq.mm.)	150 M-70 M-35 N-35 N-16 16 6 6
	d)Number of wires (No.)	As per Table 2 of IS 8130
	e) Direction of lay of stranded layers	Outmost layer shall be R.H.lay & opposite in successive layers
10	Conductor resistance(dc) at20ºC per km –maximum	0.206 0.443/0868 0.868/1.91 1.91 4.61 4.61
11	Insulation	
	a) Composition of insulator	Extruded PVC Type as per IS:5831-84
	b)Nominal thickness of insulation (mm)	2.1 1.4/1.2 1.2/1.0 1.0 1.0 1.0
	c) Minimum thickness of insulation	1.79 1.16/0.98 0.98/0.5 0.8 0.8 0.8
12	Inner Sheath	
	a) Material	Extruded PVC Type ST-I as per IS :5831 84
	b) Calculated diameter over the laid up cores(mm)	NA 27.6 20.4 15.7 11.6 9.6
	c)Thickness of sheath (minimum)mm	NA 0.4 0.3 0.3 0.3 0.3
13	Armour	as aer IS 3975/88

	a) Type and material of armour	Alum.Wire (H4 grade) Gal Steel Gal Steel Gal Steel Gal.Steel Wire Strip strip strip
	b)Direction of armouring	Left Hand
	c) Calculated diameter of cable over inner sheath (under armour),mm	18 28.4 21 16.3 12.2 10.2
	d)Nominal diameter of round armour wire strip	1.6 4*.8 4*.8 1.4 1.4
	e) Guranteed short circuit of the arnour for 0.12 sec at room temperature.	Armouring shall be as close as practicable
	f) Short circuit capacity of the armour along for 1 sec for info only	K * A √t (K amp.) (where A = total area of armour in mm sq. and t= time in second K.091 for Al. & .05 for steel
	f) D.C. resistance at 20ºC (km)	.44 2.57 3.38 3.99 3.76 4.4
14	Outer sheath	
	a) Material (PVC Type)	ST-1 & FR ST-1 & FR ST-1 & FR ST-1 &FR ST-1 &FR ST-1 & FR
	b) Calculated diameter under the sheath	21.2 30.1 22.6 17.9 15 13
	c) Min. thickness of sheath(mm)	1.4 1.56 1.4 1.4 1.4 1.24
	d) Guaranteed value of minimum oxygen index of outey sheath at 27ºC	Min. 29 Min. 29 Min. 29 Min. 29 Min. 29 Min. 29
	e) Guranteed value of minimum temperature index at 21 oxygen index	Min. 250 Min. 250 Min. 250 Min. 250 Min. 250 Min. 250
	f) colour of sheath	Black Black Black Black Black Black
15	a) Nominal Overall diameter o cable	
	b) Tolerance on overall diameter (mm)	+2/-2
16	Cable Drums	Shall confirm to IS :10418 and technical spec
	a) Max standard length per drum for each size of cable (single length)with 25% Tolerance(mtrs)	1000 /500 1000 /500 1000 /500 1000 /500 1000 /500 1000 /500
	b) Non standard drum lengths	Max.1 Non standard length of each cable size may be supplied in drums only over and above the standard length
17	Whether progressive sequential marking on outer sheath provided	Yes
18	Identification of cores	
	a) colour of cores	RED & bk r,y,bl & bk r,y,bl & bk r,y,bl & bk r,y,bl & bk
	b) Numbering	NA
19	Whether cables offered are ISI marked	Yes
20	Whether cables offered are suitable for laying as per IS 1255	Yes

STANDARD TECHNICAL DATA SHEET

Sl.No.	CUSTOMER :	CSPTCL Raipur
	Name of Manufacturer :	As per approved list
	Cable Sizes	2C x 150 3Cx2.5 5Cx2.5 7cx2.5 10Cx2.5 14Cx2.5 19Cx2.5 27Cx2.5
1	Manufacturer's type designation	YWY YWY YWY YWY YWY YWY YWY YWY
2	Applicable standard	IS:1554/PT-1/198 &its referred standards
3	Rated Voltage(volts)	1100 Vgrade
4	Type & category	FR &C1
5	Suitable for earthed or unearthed system	For both
6	Continuous current rating when laid in air in a ambient tem. of 50ºC and for maximum conductor temp. of 70ºC of PVC Cables (for information only)	22 19 19 14 12 10.5 9.7 8
7	Rating factors applicable to the current ratings for various conditions of installation:	As per IS :3961 Part II- 67
8	Short circuit capacity	
	a)Short circuit Amp(ms) KA for 1 sec duration.	0.285 0.285 0.285 0.285 0.285 0.285 0.285 0.285
	B)conductor temp. allowed for the short circuit duty (deg c)	160ºC
9	Conductor	
	a) Material	Plain annealed High Conductivity Stranded Copper (as per IS 8130/84
	b) Grade	(Electrolytic)
	c) Cross section area (sq.mm.)	2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5
	d)Number of wires (No.)	As per Table 2 of IS 8130
	e) Form of conductor	Non compacted stranded circular conductor
	f) Direction of lay of stranded layers	Outmost layer shall be R.H.lay
10	Conductor resistance(dc) at20ºC per km –maximum	7.41 7.41 7.41 7.41 7.41 7.41 7.41 7.41
11	Insulation	
	a) Composition of insulator	Extruded PVC Type as per IS:5831-84
	b)Nominal thickness of insulation (mm)	0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9
	c) Minimum thickness of insulation	0.71 0.71 0.71 0.71 0.71 0.71 0.71 0.71
12	Inner Sheath	
	a) Material	Extruded PVC Type ST-I as per IS :5831 84
	b) Calculated diameter over the laid up cores(mm)	7.2 7.8 9.7 10.8 14.4 15.9 18 22.1
	c)Thickness of sheath (minimum)mm	0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3
13	Armour	as aer IS 3975/99
	a) Type and material of armour	Gal Gal Gal Gal. Gal. Gal. Gal. Gal.

		Steel Wire Steel Wire Steel Wire Steel Wire Strip Wire strip Wire strip Wire
	b)Direction of armouring	Left Hand
	c) Calculated diameter of cable over inner sheath (under armour),mm	7.8 8.4 10.3 11.4 15 16.5 18.6 22.7
	d)Nominal diameter of round armour wire strip	1.4 1.4 1.4 1.4 1.6 1.6 1.6 1.6
	e) Number of armour wires	Armouring shall be as close as practicable
	f) Short circuit capacity of the armour along for 1 sec for info only	-0.05 x A √t(k Amp.)(where A=total area of armour in mm & =time in seconds)

1.1 KVGRADE XLPE POWER CABLES

	g) D.C. resistance at 20ºC (km)	As per IS 1554 Part (1) where ever applicable & IS 3975-1999
14	Outer sheath	
	a) Material (PVC Type)	ST-1 & FR ST-1 & FR ST-1 & FR ST-1 &FR ST-1 &FR ST-1 & FR ST-1 & FR ST-1 & FR
	b) Calculated diameter under the sheath	10.6 11.2 13.1 14.2 18.2 19.7 21.8 25.9
	c) Min. thickness of sheath(mm)	1.24 1.24 1.24 1.24 1.4 1.4 1.4 1.56
	d) Guaranteed value of minimum oxygen index of outer sheath	Min. 29.0 Min. 29.0 Min. 29.0 Min. 29.0 Min. 29.0 Min. 29.0 Min. 29.0 Min. 29.0
	e) Guranteed value of minimum temperature index at 21 oxygen index	Min. 250 Min. 250 Min. 250 Min. 250 Min. 250 Min. 250 Min. 250 Min. 250
	f) colour of sheath	Grey Grey Grey Grey Grey Grey Grey Grey
15	a) Nominal Overall diameter of cable	$
	b) Tolerance on overall diameter (mm)	+2/-2
16	Cable Drums	Shall confirm to IS :10418 and technical spec
	a) Max standard length per drum for each size of cable (single length)with ±5% Tolerance(mtrs	1000 /500 1000 /500 1000 /500 1000 /500 1000 /500 1000 /500
	b) Non standard drum lengths	Max.1 Non standard length of each cable size may be supplied in drums only over and above the standard length
17	Whether progressive sequential marking on outer sheath provided	Yes
18	Identification of cores	
	a) colour of cores	R& bk ry & bl ybl&bk grey grey grey grey grey
	b) Numbering	NA
19	Whether cables offered are ISI marked	Yes
20	Whether cables offered are suitable for laying as per IS 1255	Yes

Specifications of Armoured Copper Control cable.

No. of Cores & Cross Sectional Area NO x mm2	Thickness of PVC Insulation (Nom.) mm	Thickness of Innersheath (min.) Extruded mm	STRIP ARMOURED CABLE				WIRE ARMOURED CABLE				Standard Delivery Length in Mtrs.	Current Rating	
			Strip Size mm	Thickness of PVC Outer sheath (Min) mm	Approx. OD mm	Approx. Net weight of Cable Kg / km	Round Wire Dia mm	Thickness of PVC Outer sheath (Min) mm	Approx. OD mm	Approx. Net Weight of Cable Kg / Km		Direct in Ground Amps	In Air/ Duct. Amps
2 x 2.5	0.9	0.3	—				1.4	1.24	14.8	500	1000	32	27
3 x 2.5	0.9	0.3	—				1.4	1.24	15.4	520	1000	27	24
4 x 2.5	0.9	0.3	—				1.4	1.24	16.4	590	1000	27	24
5 x 2.5	0.9	0.3	—				1.4	1.24	17.5	660	1000	23	19
6 x 2.5	0.9	0.3	—				1.4	1.24	18.7	745	1000	21	18
7 x 2.5	0.9	0.3	—				1.4	1.24	18.7	780	1000	20	17
10 x 2.5	0.9	0.3	4 x 0.8	1.40	21.8	900	1.6	1.40	23.4	1110	1000	18	15
12 x 2.5	0.9	0.3	4 x 0.8	1.40	22.8	1020	1.6	1.40	24.4	1240	1000	17	14
14 x 2.5	0.9	0.3	4 x 0.8	1.40	23.8	1130	1.6	1.40	25.4	1340	1000	16	13
16 x 2.5	0.9	0.3	4 x 0.8	1.40	24.9	1210	1.6	1.40	26.5	1455	1000	15	13
19 x 2.5	0.9	0.3	4 x 0.8	1.40	26.1	1355	1.6	1.40	27.7	1605	1000	14	12
24 x 2.5	0.9	0.3	4 x 0.8	1.40	30.0	1655	1.6	1.56	32.0	1970	1000	13	11
27 x 2.5	0.9	0.3	4 x 0.8	1.40	30.6	1770	1.6	1.56	32.6	2100	1000	12	10
30 x 2.5	0.9	0.3	4 x 0.8	1.56	32.0	1940	1.6	1.56	33.6	2250	1000	12	10
37 x 2.5	0.9	0.4	4 x 0.8	1.56	34.7	2300	2.0	1.56	37.1	2900	1000	11	9

TECHNICAL SPCIFICATION FOR AIR CONDITIONING SYSTEM OF CONTROL ROOM & ADMINISTRATIVE BLOCK

1.00.0 GENERAL:-

1.01.0 This specification covers supply, installation, testing & commissioning of Air conditioning system for the control room building. Air conditioning units for control room building shall be so designed and set to maintain the following inside conditions.

DBT. 24.4º C ± 2 º C

1.02.0 The following rooms shall be air conditioned –

i) Control room
ii) Substation In-charge room
iii) Electronics test lab
iv) AE's room
v) Library
vi) Office staff room

1.03.0 Air conditioning requirement of rooms indicated above shall be met using split AC units. High wall type split AC units of 2TR capacity each with high wall type indoor evaporator unit shall be used for all rooms.

1.04.0 Scope:-

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

1.04.1 Minimum Fifteen (15) Nos of high wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.Necessary calculations for arriving at number of split AC units of 2TR capacity to be employed shall be submitted for approval.

1.04.2 Copper refrigerant piping complete with insulation between the indoor and remote outdoor condensers as required.

1.04.3 PVC drain piping from the indoor units up to the nearest drain point.

1.04.4 Power and control cabling between the indoor unit and outdoor unit and earthing.

1.04.5 MS brackets for outdoor condensing units, condensers as required.

2.00.0 Specification for split AC units.

2.01.0 The split AC units will be completed with indoor evaporator unit, outdoor condensing units and cordless remote control units.

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

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

2.04.0 The split AC units shall be Hitachi, Daikin make.

LIGHTING SYSTEM

1. Lighting system:-

1.1 The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry and accessories, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel conduits, lighting wires, GI earth wire, receptacles, tag block and telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, lighting transformer.

1.2 AC Normal lighting:-

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.2.1 AC Emergency lighting:-

This system will be available in control room building, fire lighting pump house, DG set building & switchyard. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the emergency lighting board which is fed from diesel generator during the emergency. 50% of lighting fixtures shall be connected on AC emergency lightening.

12.2 DC Emergency lighting:-

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, battery charger room, lt switchgear room, in control room building. Fire fighting pump house and DG set building, so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and bulkhead fixtures in non false ceiling area to be used.

Portable fixtures:-

Three numbers of battery operated, portable fixtures will be provided in the control room building and one number shall be provided in DG set building cum fire fighting pump house.

High Mast Lighting

The contractor shall provide ten numbers 25 meters high Tubular High Mast Lighting. It shall be in three sections and shall include accessories for high mast including head frame, steel wire rope 6mm dia(7/19 construction),double drum with lantern carriage arrangement carrying luminaries symmetrically in eight nos fittings around the periphery.Each fitting shall have 2X240W LED floodlights.The high mast shall have integral power tool installed at the base apartment for motorised operation of the fittings). Control panel shall be provided at the base. Also, provision of manual movement of fittings shall be provided. The high mast shall be of hot dip galvanised and suitable for wind velocity as per IS 875.

Ceiling fans (1400mm sweep, AC 230 volts) shall be provided in DG set building, fire fighting pump house and non AC rooms in the control room building as shown in the enclosed drawings. Wall mounted fans shall be provided in the conference room, Shift In Charge and Substation in-charge rooms in control room building. Exhaust fans shall be provided in toilets.

1 No. of aluminium ladder of each size shall be supplied by the contractor for maintenance purpose.

The following specific areas are included in the scope of lighting :

i) Switchyard area
ii) Switchyard control room cum administrative office building
iii) DG building cum fire fighting pump house
iv) Street lighting (peripheral) inside switchyard fencing (street lighting shall be done using street lighting poles)
v) Landscape lighting around control room as shown in the tender drawing.

12.3 For Outdoor street lighting Illumination:-

The street lighting design, detailed drawings showing the lighting layout and Electrical distribution diagram of high mast and street lighting shall be prepared by the contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles etc.

12.4 For Indoor Illumination:-

The conduit layout for substation buildings based on the tender drawings, Electrical distribution diagram for substation buildings and for landscape lighting cable schedule for substation yard etc. shall be prepared by the contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of control room cum Administrative office building and DG building cum fire fighting pump house.

12.5 Description of items:-

The contractor shall supply and install the following equipment and accessories in accordance with the specification.

12.6 Lighting panels:-

Outdoor:- 415 AC lighting panel with 415V, 63A, 3 phase 4 wire bus and one No.63A, TPN, MCB with neutral unit as incomer and 20A, MCB as outgoing feeders.

Indoor:- 415 AC lighting panel with 415V, 63A, 3 phase 4 wire bus and one No.63A, TPN, MCB with 300ma RCCB. Flush mounted with per phase isolation and indication lamps din mounted. The DB will be flush mounted.

12.7 220V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button control panels.

Sl. No.	Type of Lighting Fixture	Description
1.	**FI**	2x16W LED lamps in fixture, complete with HF Electronic Ballast and suitable for pendent /surface Mounting,
2.	**FB**	9W LED lamp in Bulkhead fixtures
3.	**FF**	2x16W LED lamp with mirror optics in surface mounting type decorative fluorescent fitting with HF Electronic Ballast and excellent glare
4.	**IF**	Incandescent GLS lamp in recessed down light having high purity aluminium reflector electrochemically brightened and anodized. Stainless steel leaf springs and pressure die cast ceiling
5.	**DSM**	1X16WATT surface mounted LED
6.	**CL**	3X 16 W LED Decorative ceiling mounted luminaire.
7.	**PF**	1x11 W LED Lamp emergency light with Battery operated portable fixture with built in chargeable Batteries and battery

		charger suitable for a lighting period of six hours
8.	**SF3**	1 X 350W LED high flood lighting fixture mounted on Swivel support, integral control gear: similar to Phillips cat. No. SWF 330/ CGL Cat. No. FAI25IHSV/ Bajaj Cat. No. BJEFL 14.
9.	**SF4**	2 X 250W LED high flood lighting, non-integral control gear: similar to Phillips cat. No. RVP301/ CGL Cat. No.FHD1424 / Bajaj Cat. No. BJHM 22 SS
10.	**SC**	50W LED lamp in street lighting luminare
11.	**BL**	2X9 or 1x18 watt LED bollard light for landscape lighting having FRP/LLDPE housing,
12.	**SC**	50W lamp in street lighting luminare. A special optical reflector clear acrylic cover, a single piece die cast aluminium housing made out of LM6 and corrosion resistance proof. Similar to Philips Cat No. SRX-51 and Bajaj Cat No. BJMSDT/150 / Crompton Greaves Cat No. SSG 23151H .(Street Light Luminaire should be suitable for Bottom Entry/Side entry both for pipe mounting)

* * * *

PRICE VARIATION FORMULA FOR POWER TRANSFORMERS

CIN No. U99999MH1970GAPO14629

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your link to electricity
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IEEMA/PVC/PWR TRF_upto 400 KV/2015

Effective from: 1st April 2015

PRICE VARIATION CLAUSE FOR POWER TRANSFORMERS AND REACTORS COMPLETE WITH ALL ACCESSORIES AND COMPONENTS of ratings above 10 MVA or voltage above 33 kV up to 400 kV Of supplied against domestic contracts

This price variation clause is applicable for 'Power Transformers', ratings above 10 MVA or voltage above 33 kV up to 400 kV. The clause is to be used for domestic contracts. A separate price variation IEEMA/PVC/PWR TRF_upto 400 KV/DE/2015has been evolved for above types of Transformers supplied against export/deemed export contracts under special imprest licensing scheme.

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(10 + 29\,\frac{C}{C_0} + 27\,\frac{ES}{ES_0} + 7\,\frac{IS}{IS_0} + 5\,\frac{IM}{IM_0} + 7\,\frac{TO}{TO_0} + 15\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, **ONE** month prior to the date of tendering.

ES_0 = Price of CRGO Electrical Steel Lamination (refer note)
This price is as applicable on the 1st working day of the month, **ONE** months prior to the date of tendering.

IS_0 = Average price of steel Plates 10 mm thick (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of tendering.

IM_0 = Price of Insulating Materials (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** months prior to the date of tendering.

TO_0 = Price of Transformer Oil (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, **THREE** months prior to the date of tendering.

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For example, if date of tendering falls in June 2015, applicable prices of Copper Wire Bars (C_0), Transformer Oil (TO_0), Steel Plates 10 mm thick (IS_0), CRGO Electrical Steel Laminations (ES_0) and Insulating material (IM_0) should be as on 1st May 2015 and all India average consumer price index no. (W_0) should be for the month of 1st March 2015.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/PWR_TRF/_/_ **ONE** month prior to the date of tendering.

C = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, **TWO** months prior to the date of delivery.

ES = Price of CRGO Electrical Steel Lamination (refer notes)
This price is as applicable on the 1st working day for the month, **TWO** months prior to the date of delivery.

IS = Average price of Steel Plates 10 mm thick (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of prior to the date of delivery.

IM = Price of Insulating Materials (refer notes)
This price is as applicable on the 1st working day of the month, **TWO** months prior to the date of delivery.

TO = Price of Transformer Oil (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, **THREE** months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2015, applicable prices of Copper Wire Bars (C), Insulating material (IM), CRGO Electrical Steel Lamination (ES) should be as on 1st October 2015 and Transformer Oil (TO), Plates 10 mm thick (IS) should be 1st November 2015 and all India average consumer price index no. (W) should be for the month of September 2015.

The date of delivery is the date on which the transformer is notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

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IEEMA/PVC/PWR TRF_upto 400 KV/2015

Effective from: 1st April 2015

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc. transformers manufacturers import major raw materials like Copper, CRGO Steel Sheets and Plates etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1. The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars converted into Indian Rupees with applicable average exchange rate of SBI of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
2. The price of CRGO is the price of CRGO Electrical Steel Lamination in Rs./MT suitable for Transformers of rating above 10 MVA or voltage above 33 kV up to 400 kV
3. Price of steel is the average retail price of steel plates 10 mm thick as published by Joint Plant Committee (JPC) in Rs./MT as on 1st working day of the month.
4. The price of Insulting materials (in Rs./Kg) of pre-compressed pressboards of size 10 mm thick, 3200 mm x 4100 mm is the average C&F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month as quoted by primary suppliers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
5. The price of Transformer Oil (in Rs./K.Ltr) is the average price on ex-refinery basis as quoted by primary producers for supply in drums.

(d) Some purchasers are purchasing oil immersed Transformers from manufacturers without first filling of oil. Oil for first filling is procured and filled by the purchasers. For such supplies PVC formula, excluding Oil will apply as under:

$$P = \frac{P_0}{93}\left(10 + 29\frac{C}{C_0} + 27\frac{ES}{ES_0} + 7\frac{IS}{IS_0} + 5\frac{IM}{IM_0} + 15\frac{W}{W_0}\right)$$

Where description of P, P_0, C, ES, IS, IM, W etc. remains same as mentioned earlier.

Deputy Director General

IEEMA/PVC/PWR TRF_upto 400 KV2015/3/3

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PRICE VARIATION FORMULA FOR INSTRUMENT TRANSFORMERS

(72.5 KV & ABOVE)

The price quoted/ confirmed is based on the input cost of raw materials /components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down, in accordance with the following formula:

$$P=P_0/100[18+13(C/C_0)+12(ES/ES_0)+12(IS/IS_0)+23(IM/IM_0)+6(TB/TB_0)+16(W/W_0)]$$

Wherein

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/ confirmed.

C_0 = Average LME settlement price of Copper wire bars (refer Notes)

This price is as applicable for the month, two months prior to the date of tendering.

ES_0 = C & F price of CRGO Electrical Sheet Steels (refer Notes)

IS_0 = Whole Sale Price Index Number for "Iron & Steel (Base 1993-94=100)" (refer Notes)

IM_0 = IEEMA Index for Insulator (Base January 2003 =100) (refer Notes).

This index is as applicable on the first working day of the month, One month prior to the date of tendering.

TB_0 = Price of Transformer Oil base stock (refer Notes)

This price is as applicable on the 1st working day of the month, two months prior to the date of tendering.

W_0 = All India Average Consumer Price Index number for industrial workers, as published by Labour Bureau, Ministry of Labour, Government of India (Base 1982=100).

This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2005, the applicable prices of Copper Wire Bars (C_0) and transformer oil base stock (TB_0) should be for the month of August 2005, whereas the applicable price price of CRGO sheet (ES_0) and IEEMA Index for insulator (IM_0) should be as on 1st September 2005 and Whole Sale Price Index number of Iron & Steel should be for the week ending first Saturday of July 2005; and all India Average Consumer Price Index number (W_0) should be for the month of July 2005.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA/ PVC/ CTPT/ __/ __ prevailing as on the first working day of the month _____ i.e. ONE month prior to the date of tendering.

C = Average LME settlement price of Copper wire bars (refer notes).

This price is as applicable for the month, two months prior to the date of delivery.

ES = C&F price of CRGO Electrical Steel Sheets (refer Notes)

This price is as applicable on the 1st working day for the month, one month prior to the date of delivery.

IS = Whole Sale Price Index Number for "Iron & Steel (Base 1993-94=100)" (refer Notes)

This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of delivery.

IM = IEEMA Index for Insulator (Base January 2003 =100) (refer Notes).

This index is as applicable on the 1st working day of the month, one month prior to the date of delivery.

TB = Price of Transformer Oil base stock (refer Notes)

This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

W = All India Average Consumer Price Index number for industrial workers, as published by Labour Bureau, Ministry of Labour, Government of India (Base 1982=100).

This index number is as applicable on the first working day of the month, threemonths prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2005, the applicable prices of Copper Wire Bars (C) and transformer oil base stock (TB) should be for the month of October 2005, where as the applicable price price of CRGO sheets (ES) and IEEMA Index for insulator (IM) should be as on 1st November 2005 and Whole Sale Price Index number of Iron & Steel (IS) should be for the week ending first Saturday of September 2005; and all India Average Consumer Price Index number (W) should be for the month of September 2005.

The date of delivery is the date on which the instrument transformer is notified as being ready for inspection/ despatch (in the absence of such notification, date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto) whichever is earlier.

Notes:-

(a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other Central, State or local taxes, Octroi etc. Instrument transformer manufacturers import major raw materials like

Copper, CRGO Electrical Steel Sheets and TOBS etc. The landed cost of these imported raw materials include applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:-

1. The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for ONE month prior to the month of circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
2. the price of CRGO Electrical Steel Sheets (in Rs./MT) is the average of C&F price in US $ per MT converted into Indian Rupees with applicable exchange rate prevailing as on 1st working day of the month, as quoted by primary producers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
3. The wholesale price index number for "iron & Steel" is as published by the office of Economic Advisor, Ministry of Industry, Government of India, NewDelhi with base 1993-94=100. This whole sale price index number is being published weekly on provisional basis. However, the same gets finalised after eight weeks and is normally available after two months. Therefore we are considering in our calculations this final index for the first Saturday of the month two months prior to the date of which the prices of other raw materials such as Al, IM are published for the corresponding month.
4. IEEMA index number for insulator (Base year 2003=100) is published as basic price circular for insulator vide reference IEEMA (PVC)/INSLR/____/ ____ applicable for IEEMA price variation clauses for insulator viz. IEEMA (PVC)/ INSLR effective from 01st April 2003.
5. The Price of TOBS is C&F price (in Rs./K.Ltr) for Group II grade 70 Base Oil as published in ICIS-LOR bulletin for the 1st week of previous month. This price is normally published in US$ per US gallon, which is converted in Rs./K.Ltr. with applicable exchange rate prevailing as on 1st working day of the subsequent month. This price is landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

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IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005 Effective from: 1st June 2005

PRICE VARIATION CLAUSE FOR INSTRUMENT TRANSFORMERS BELOW 72.5 KV
(Current and Potential Transformers designed for operation on system voltage below 72.5 KV)

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(18 + 18\,\frac{C}{C_0} + 20\,\frac{ES}{ES_0} + 10\,\frac{IS}{IS_0} + 12\,\frac{ER}{ER_0} + 09\,\frac{TB}{TB_0} + 13\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of tendering.

ES_0 = C&F price of CRGO Electrical Steel Sheets (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

IS_0 = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

ER_0 = Price of Epoxy Resin (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tending.

TB_0 = Price of Transformer Oil Base Stock (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2005, the applicable prices of Copper Wire Bars (C_0) and Transformer Oil Base Stock (TB_0) should be for the month August 2005, where as the applicable price of CRGO Electrical Steel Sheets (ES_0) and Epoxy Resin (ER_0) should be as on 1st September 2005 and Wholesale price index number for 'Iron & Steel' (IS_0) should be for the week ending first Saturday of July 2005 and all India average consumer price index number (W_0) should be for the month of July 2005.

Reply to: IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005/01/03

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PRICE VARIATION FORMULA FOR COUPLING CAPACITOR

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IEEMA/PVC/CAP_PWR/2009

Effective from: 1st July 2009

PRICE VARIATION CLAUSE FOR POWER CAPACITORS

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(18 + 16\,\frac{CO}{CO_0} + 17\,\frac{AF}{AF_0} + 26\,\frac{BO}{BO_0} + 23\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

CO_0 = Price of Non-PCB Condenser Oil (refer notes)
This price is as applicable for the month, one month prior to the date of tendering.

AF_0 = Average LME settlement price of Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

BO_0 = Price of BOPP Film (refer notes)
This price is as applicable for the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2010, the applicable prices of Non-PCB Condenser Oil (CO_0), LME average settlement price of Aluminium (AF_0) and BOPP Film (BO_0) should be for the month September 2010, and all India average consumer price index number (W_0) should be for the month of July 2010.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/CAP_PWR/_/_ prevailing as on first working day of the month ....., i.e., one month prior to the date of tendering.

CO = Price of Non-PCB Condenser Oil (refer notes)
This price is as applicable for the month, one month prior to the date of delivery.

AF = Average LME settlement price of Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.

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BO = Price of BOPP Film (refer notes)

This price is as applicable for the month, one month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)

This index number is as applicable on the first working day of the month, three months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2010, the applicable prices of Non-PCB Condenser Oil (CO), LME average settlement price of Aluminium (AF) and BOPP Film (BO) should be for the month November 2010, and all India average consumer price index number (W) should be for the month of September 2010.

The date of delivery is the date on which the Power Capacitor is notified as being ready for inspection/dispatch. In the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc. Power Capacitor manufacturers import major raw materials like Non-PCB Condenser Oil, Aluminium Foil and BOPP Film. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The Non-PCB Condenser Oil price (in Rs./MT) is Jarylec Base Oil Grade- C101D as received from an imported supplier in foreign currency. The price is converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

2) The LME price of Aluminium (in Rs./MT) is the LME average settlement price of Aluminium converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The BOPP Film price of 10 micron thickness (in Rs./Kg) is as received from an imported supplier in foreign currency. The price is converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

Authorized Signatory

IEEMA/PVC/CAP_PWR/2009/02/02

PRICE VARIATION FORMULA FOR ISOLATORS AND SWITCHGEARS ABOVE 36KV

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IEEMA/PVC/HT-SWGR (ABOVE 36KV)/2007 Effective from: 1st June 2007

PRICE VARIATION CLAUSE FOR HT SWITCHGEAR AND CONTROLGEAR (ABOVE 36KV)

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula.

The price variation clause is split up into two parts. Part-I is for indigenous content of the switchgear and Part-II is for the import content of the switchgear.

Part-I: Part variation clause for indigenous content of the switchgear (above 36KV)

$$P = \frac{P_0}{100}\left(19 + 17\,\frac{IS}{IS_0} + 17\,\frac{C}{C_0} + 13\,\frac{AL}{AL_0} + 19\,\frac{IN}{IN_0} + 15\,\frac{W}{W_0}\right) - P_0$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

IS_0 = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of tendering.

AL_0 = Price of Busbar grade Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

IN_0 = IEEMA index for insulator (Base: January 2003=100) (refer notes)
This index number is as applicable on the 1st working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 2001 = 100)
This index number is as applicable on the first working day of the month, four months prior to the date of tendering.

For example, if date of tendering falls in May 2006, the applicable prices of average LME Copper Wire Bars (C_0) should be for the month March 2006, where as the applicable price of Busbar grade Aluminium (AL_0) and IEEMA index of Insulator (IN_0) should be as on 1st April 2006 and Wholesale price index number for 'Iron & Steel' (IS_0) should be for the week ending first Saturday of February 2006 and all India average consumer price index no. (W_0) should be for the month of January 2006.

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IEEMA/PVC/HT-SWGR (ABOVE 36KV)/2007 Effective from: 1st June 2007

E = IEEMA's Banker's selling rate of exchange between foreign currency and Indian Rupees expressed in concerned foreign currency equivalent to Rupees 100 prevailing on the first Bankers working day four months prior to the date of delivery (refer notes)

D = Effective import duty rate in percentage (Excluding duties set off against MODVAT) as per item no. 85.38 of customs tariff act in so far as it applies to the parts of customs tariff item 85.35 prevailing on 1st working dat of the calendar month, two months prior to the date of delivery.

D_0 = Effective import duty rate in percentage (Excluding duties set off against MODVAT) as per item no. 85.38 of customs tariff act in so far as it applies to the parts of customs tariff item 85.35 prevailing on 1st working dat of the calendar month, one month prior to the date of tendering.

EC = Rate of exchange between foreign currency and Indian Rupees expressed in foreign currency equivalent to Rs. 100/- adopted by Customs prevailing on first working day of the calendar month, two months prior to the date of delivery (refer notes)

EC_0 = Rate of exchange between foreign currency and Indian Rupees expressed in foreign currency equivalent to Rs. 100/- adopted by Customs prevailing on first working day of the calendar month, one month prior to the date of tendering (refer notes)

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc. transformers manufacturers import major raw materials like Copper, CRGO Steel Sheets, TOBS and insulating pressboards etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The wholesale price index number for 'Iron & Steel' is as published by the Office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations this final index for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as Al, IN are published for the corresponding month.

2) The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The price of Busbar grade Aluminium (in Rs./MT) is the average Ex-works price as quoted by primery producer of the Busbar size 152.4 x 6.35 mm flat approx. of grade equivalent to E91E as per IS 5082-1981 or latest.

4) The exchange rates that would be published by IEEMA would be for the following currencies only.
1) US Dollars 2) Pound Sterling 3) Japanese Yen 4) Euro

Authorized Signatory

PRICE VARIATION FORMULA FOR ISOLATORS AND SWITCHGEARS (BELOW 36 KV)

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IEEMA/PVC/SWGR/2001 (R-1) *Effective from : 1st January, 2002*

PRICE VARIATION CLAUSE FOR SWITCHGEAR AND CONTROLGEAR

The price quoted/confirmed is based on the cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials / components and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and Index number, the price payable shall be subject to adjustment up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(25 + 17\,\frac{IS}{IS_0} + 18\,\frac{C}{C_0} + 10\,\frac{Al}{Al_0} + 13\,\frac{In}{In_0} + 17\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with above formula.

P_0 = Price quoted/confirmed.

IS_0 = Wholesale price index of 'Iron and Steel' (base: 1993-94 = 100) (refer notes).
This index is as applicable on the first week ending Saturday of the month, three months prior to the date of tendering.

C_0 = Price of electrolytic copper wire bars (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

Al_0 = Price of busbar grade aluminium (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

In_0 = Price of phenolic moulding powder for switchgear and controlgear of medium/lower voltage (upto 650 volts) or price of epoxy resin for HT switchgear (above 650 volts) (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, four months prior to the date of tendering.

For example, if the date of tendering falls in May 2001, the applicable prices of electrolytic copper wire bars (C_0), busbar grade aluminium (Al_0) and insulating material (In_0) should be for the month of April 2001 and wholesale price index of 'Iron and Steel' (IS_0) should be for the first week ending Saturday of February 2001 and all India average consumer price index number (W_0) should be for the month of January 2001.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)SWGR/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

IS = Wholesale price index of 'Iron and Steel' (base: 1993-94 = 100) (refer notes).
This index is as applicable on the first week ending Saturday of the month, four months prior to the date of delivery.

C = Price of electrolytic copper wire bars (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

IEEMA/PVC/SWGR/1/2

Al = Price of busbar grade aluminium (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

In = Price of phenolic moulding powder for switchgear and controlgear of medium/lower voltage (upto 650 volts) or price of epoxy resin for HT switchgear (above 650 volts) (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, five months prior to the date of delivery.

For example, if the date of delivery in terms of clause given below falls in December 2001 the applicable price of raw materials viz: C, Al and In should be for the month of October 2001 and wholesale price index of 'Iron and Steel' (IS) should be for the first week ending Saturday of August 2001 all India average consumer price index number (W) should be for the month of July 2001.

The "date of delivery" is the date on which the switchgear equipment is notified as being ready for inspection/despatch. (In the absence of such notification the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The wholesale price index number for 'Iron and Steel' is as published by the office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi, with base 1993-94 = 100. This wholesale price index is being published weekly on provisional basis. However, the same gets finalised after eight weeks and is normaly available after two months. Therefore, we are considering in our calculations this final index published by Economic Advisor for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as C, Al and In are published for the corresponding month.

2) The price for electrolytic copper wire bars (in Rs/MT) is ex-godown price as quoted by the primary producer of copper.

3) The price of busbar grade aluminium (in Rs/MT) is the average of ex-works price as quoted by the two primary producers for the busbar size 152.4 x 6.35 mm flat approxi mately, of grade equivalent to E91E as per IS 5082-1981 (or the latest).

4) The price of insulating material (in Rs/Kg)

is the average price of phenolic moulding powder quoted by three manufacturers. (for switchgear and controlgear of medium/lower voltage upto 650 volts). **or**

is the price of epoxy resin quoted by a resin manufacturer for their grade CT 5900 or its nearest equivalent. (for HT switchgear above 650 volts).

For Indian Electrical & Electronics Manufacturers' Association

Authorised Signatory

PRICE VARIATION FORMULA FOR LIGHTING ARRESTORS

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ISO 9002

IEEMA/PVC/ARSTR/2001 Effective from : 1st September 2001

PRICE VARIATION CLAUSE FOR ZINK OXIDE GAPLESS LIGHTNING ARRESTER

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below in case of any variation in these raw material prices/indices, the price payable shall be subject to adjustment up or down, in accordance with the following formula:

$$P = \frac{P_0}{100}\left[20 + 15\frac{ZN}{ZN_0} + 15\frac{CO}{CO_0} + 10\frac{BI}{BI_0} + 10\frac{BC}{BC_0} + 10\frac{FP}{FP_0} + 15\frac{W}{W_0} + 5\frac{AL}{AL_0}\right]$$

Wherein,

P = Price payable as adjustable in accordance with the above formula.

P_0 = price quoted/confirmed

ZN_0 = Price of electrolytic high grade zinc (refer note).
This price is as applicable on the first working day or the month, one month prior to the date of tendering.

CO_0 = Price of Cobalt (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

BI_0 = Price of Bismuth (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

BC_0 = Price of Ball Clay (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

AL_0 = Price of Aluminium Ingots (refer notes)
This price is as applicable as the 1st working day of the month, one month prior to he date of tendering.

FP_0 = Wholesale price index number for fuel, power, Light & Lubricants (refer notes).
This index number is as applicable for the 1st Saturday of the month, three months prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable for the month, three months prior to the date of tendering.

IEEMA/PVC/ARSTR/2001 Effective from :1st September 2001

For example, if the date of tendering falls in May 2001, the applicable basic price of raw materials i.e. ZN_o, CO_o, BI_o, AL_o and BC_o should be as circulated by IEEMA as on 1st April 2001 and the applicable wholesale price index number for fuel, power, light and lubricants (FP_o) should be for the week ending 1st Saturday of the month of February 2001 and all India average consumer price index number (W_o) should be for the month of February 2001.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)ARSTR/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

ZN = Price of electrolytic high grade zinc (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

CO = Price of Cobalt (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of the delivery.

BI = Price of Bismuth (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

BC = Price of Ball Clay (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

AL = Price of EC Grade Aluminium Ingots (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

FP = Wholesale price index number for Fuel, Power, Light & Lubricants (refer notes)
This index number is as applicable for the 1st Saturday of the month, four months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, four months prior to the date of delivery.

If the date of delivery in terms of clause given below falls in December 2001, the applicable price viz: ZN, CO, BI, BC and AL should be those as published by IEEMA prevailing as on 1st October 2001 and the applicable wholesale price index number (FP) and all India average consumer price index number (W) both should be for the month of August 2001.

The date of delivery is the date on which the lightening arresters are notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto whichever is earlier.

PRICE VARIATION CLAUSE FOR FABRICATED AND GALVANIZED TRANSMISSION LINE TOWER/ GI STRUCTURES

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IEEMA/PVC/TLT/2010 (R-1) **Effective from: 1st April 2014**

PRICE VARIATION CLAUSE FOR TRANSMISSION LINE TOWERS

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

(A) Transmission Line Tower with both Heavy and Light angles

$$P = \frac{P_0}{100}\left(11 + 32\,\frac{SBLR}{SBLR_0} + 25\,\frac{SBIR}{SBIR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

(B) Transmission Line Tower with only Heavy angles

$$P = \frac{P_0}{100}\left(11 + 57\,\frac{SBLR}{SBLR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

(C) Transmission Line Tower with only Light angles

$$P = \frac{P_0}{100}\left(11 + 57\,\frac{SBIR}{SBIR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

$SBLR_0$ = Price of Steel Blooms- Retail (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

$SBIR_0$ = Price of Steel Billets- Retail (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

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Indian Electrical & Electronics Manufacturer's Association

Zn_0 = Price of Electrolytic high grade zinc (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100) (Refer notes)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in May 2014, the applicable prices of Steel Bloom-Retail ($SBLR_0$), Steel Billets-Retail ($SBIR_0$) and Zinc (Zn_0) should be for the month April 2014 and all India average consumer price index number (W_0) should be for the month of February 2014.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA (PVC)/TLT-2014/_/_ one month prior to the date of tendering.

SBLR = Price of Steel Bloom-Retail (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

SBIR = Price of Steel Billets-Retail (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

Zn = Price of Electrolytic high grade zinc (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100) (refer notes)
This index number is as applicable on the first working day of the month, four months prior to the date of delivery.

For example, if date of delivery falls in December 2014, the applicable prices of Steel Bloom-Retail (SBLR), Steel Billets-Retail (SBIR) and Zinc (Zn) should be for the month October 2014 and all India average consumer price index number (W) should be for the month of August 2014.

The date of delivery is the date on which Transmission line towers are notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc.
(b) All prices are as on first working day of the month.
(c) The details of prices are as under:

1. The prices of Steel Bloom-Retail are the average Retail price of Blooms of size 150 x 150 mm of all cities in Rs/MT; as published by Joint Plant Committee (JPC), Kolkata. **Heavy angles of size above 110mm x 110mm are deemed to be related to this price.**

2. The prices of Steel Billet-Retail are the average Retail price of Billets of size 100 mm of all cities in Rs/MT; as published by Joint Plant Committee (JPC), Kolkata. **Light angles of size below & including 110mm x 110mm are deemed to be related to this price.**

3. The price of Electrolytic high grade zinc (in Rs/MT) is ex-works price as quoted by a primary producer.

4. Cost weightage of re-rolling/conversion charges is included in Labour cost weightage (W)

Deputy Director General