

THE SINGARENI COLLIERIES COMPANY LTD

(A Government Company)



SINGARENI THERMAL POWER PROJECT STAGE-II (1 X 800 MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B

(BOOK 2 OF 5 – ELECTRICAL)

SECTION - VI

BIDDING DOCUMENT NO.: CW-CM-11159-C-O-M-001

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ELECTRICAL

**SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW)
EPC PACKAGE
BID DOC NO.:CW-CM-11159-C-O-M-001**

**TECHNICAL SPECIFICATION
SECTION - VI
PART-B**



ELECTRICAL

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GENERAL ELECTRICAL REQUIREMENTS

CLAUSE NO.	TECHNICAL REQUIREMENTS																			
1.00.00	GENERAL REQUIREMENTS																			
1.01.00	For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% shall be considered. The equipment shall operate in a highly polluted environment. However, for equipment in air-conditioned areas, design ambient temperature shall be 35 deg.C, if 2x100% air conditioning system is provided.																			
1.02.00	All equipment's shall be suitable for rated frequency of 50Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification. The step-up voltage level for the project shall be 400KV. The turbo generator unit will be connected to its own step-up transformers for feeding power into the EHV grid. The overall system shall be designed considering voltage variation of +/- 5% and fault level of 50kA for 1 Sec for 400KV system. Under weak grid condition the minimum fault level of 2500 MVA shall be considered at 400 KV.																			
1.03.00	Contractor shall provide fully compatible electrical system, equipment's, accessories and services for the entire station/plant in his scope as well as those specifically required by the Employer.																			
1.04.00	All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and International Codes & Standards, especially the Indian Statutory Regulations.																			
1.05.00	The auxiliary AC voltage supply arrangement shall have, 11 kV, 3.3KV and 415V systems. It shall be designed to limit voltage variations as given below under worst operating condition: <table><tr><td>a)</td><td>11KV/3.3KV</td><td>+/- 6%</td></tr><tr><td>b)</td><td>415 V/240 V</td><td>+/- 10%</td></tr><tr><td>c)</td><td>220V/110V DC</td><td>-15% to +10%</td></tr></table>				a)	11KV/3.3KV	+/- 6%	b)	415 V/240 V	+/- 10%	c)	220V/110V DC	-15% to +10%							
a)	11KV/3.3KV	+/- 6%																		
b)	415 V/240 V	+/- 10%																		
c)	220V/110V DC	-15% to +10%																		
1.06.00	The voltage level for motors shall be as follows: <table><tr><td>a)</td><td>Upto 0.2 KW</td><td>:</td><td>Single phase 240V AC / 3 phase 415V AC</td></tr><tr><td>b)</td><td>Above 0.2 KW and upto 200 KW</td><td>:</td><td>3 phase, 415V AC</td></tr><tr><td>c)</td><td>Above 200 KW and upto 1500 KW</td><td>:</td><td>3 phase, 3.3 kV AC</td></tr><tr><td>d)</td><td>Above 1500 KW</td><td>:</td><td>11 kV</td></tr></table> Bidder may offer 3.3 kV motors for drives above 160 kW however all CHP Conveyor motors above 160 kW shall necessarily be fed from 3.3 kV Supply. The voltage rating of the drives				a)	Upto 0.2 KW	:	Single phase 240V AC / 3 phase 415V AC	b)	Above 0.2 KW and upto 200 KW	:	3 phase, 415V AC	c)	Above 200 KW and upto 1500 KW	:	3 phase, 3.3 kV AC	d)	Above 1500 KW	:	11 kV
a)	Upto 0.2 KW	:	Single phase 240V AC / 3 phase 415V AC																	
b)	Above 0.2 KW and upto 200 KW	:	3 phase, 415V AC																	
c)	Above 200 KW and upto 1500 KW	:	3 phase, 3.3 kV AC																	
d)	Above 1500 KW	:	11 kV																	
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	indicated above is for basic guideline. Minor variations in above can be accepted on case-to-case basis based on techno-economic considerations of the various sub-systems. Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard.			
1.07.00	The preferred AC control supply voltage shall be 110V for all 415 V non breaker controlled feeders. Control supply voltages other than above may be offered by bidder based on the bidder's standard proven practice.			
1.08.00	The designed fault level for various voltage levels shall have the following minimum values: 11 KV systems - 50 kA rms for 1 second 3.3 KV systems - 40 kA rms for 1 second 415 V systems - 50 kA rms for 1 second 240V AC: - 9kA (RMS) for 1 Sec.			
1.09.00	The nominal voltage of main DC system shall be 220V. DC batteries shall be designed for continuous float operation with trickle charge, hence all the associated components like batteries, battery chargers, DC motors, relays, contactors, timers etc. shall be suitable for continuous operation at the maximum continuous battery float voltage including suitable temperature correction factors.			
1.10.00	The Contractor shall furnish calculations of maximum loading and fault levels under the most onerous conditions for the various equipment/systems as defined elsewhere in the specification to prove adequacy of their parameters. In case any equipment or system is found to be inadequate, it shall be changed/ modified without any additional financial liability to the Employer.			
1.11.00	Transformer voltage ratios, taps, impedances and tolerances thereon, shall be optimized so that the auxiliary system voltages under various grid and loading conditions are always within permissible limits and equipment are not subjected to unacceptable voltages during operation and starting of motors such as MDBFP, ID fans etc. The vector groups of the transformers shall be so selected that all the buses of particular voltage level shall have same vector within the plant. Locked rotor MVA of ID Fan and MDBFP motors shall be restricted to 90 MVA.			
1.12.00	In fire hazardous areas like gas/ liquid fuel storage/ handling areas, lighting fixtures, and switchgears shall be flame proof.			
1.13.00	The responsibility of coordination with electrical agencies /TAC/Pollution control board and obtaining all necessary clearances shall be of the contractor.			
1.14.00	Provenness of the Equipment, system, being offered by the bidder should satisfy the criteria Indicated in the "Provenness criteria" indicated elsewhere in the specification.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.00.00	ELECTRICAL SCHEME FOR ELECTRICAL POWER DISTRIBUTION			
	For Electrical Power Distribution the Station Transformer scheme for the project as conceived by the Employer is indicated in tender SLD. (Refer Single Line Diagram enclosed with the specification documents enlisted in the Part-E, Section-VI of technical specification) The scheme with minor variations to above may also be offered as long as they meet the redundancies indicated in the above drawings and sizing criterion specified.			
2.01.00	The power supply shall be designed with unitized and Station load concept. All auxiliaries/systems required for operation of the unit like ID Fan, Booster Fan, FD Fan, PA Fan, Coal Mills, CEP, ESP, FGD unitized loads, Ash Extraction etc. shall be fed from respective unit's power supply system. Facilities/auxiliaries/systems required for more than one unit like Coal Handling, Ash Handling, Water System, FGD common loads, Fuel Oil, etc. shall be fed from Station power supply system as shown in the Electrical Single Line Diagram. Plant and service air Compressors shall be fed from Unit 3.3kV switchgear. CW pumps and CW service switchgear shall be fed from unit switchgears. As indicated in the schemes, As a minimum, each unit power supply system shall have two Nos. of Unit Transformers, two Nos. of Unit Auxiliary Transformers along with required number of auxiliary/LT transformers. In order to ensure safe shut down of the plant under emergency condition and to provide backup in case of total power failure, oneDiesel Generating set and 1 no. of Standby DG set shall be provided. A separate DG set shall be provided for FGD area. Unit shall have 2 Nos. Unit Transformers and 2 No. dedicated Station transformer as indicated in the Single Line Diagram. In addition to meeting the requirements of Station Power Supply System, this Station transformer shall provide backup to Unit Power Supply system during unit start-up, shutdowns, HP-LP bypass condition and outage of unit transformer as indicated in the sizing criteria.			
2.02.00	The overall system shall be such that failure of any one-unit auxiliary like transformer, DC battery, Battery charger and DG set shall not reduce the plant's generating capability or affect the safe shut down requirements of the unit.			
2.03.00	NA			
3.00.00	SIZING & DESIGN			
3.01.00	Generator			
	Three phase, horizontal mounted, indoor installed, two-pole, Thermal Class 155 (F) winding insulation, Stator water/Hydrogen cooled, cylindrical hydrogen / water cooled rotor type. a) Generator and its excitation system shall have a capability of at least matching the declared maximum continuous rated output of the associated steam turbine for the design maximum secondary cooling water temperature (ECW temperature) at all power factors between 0.85 lagging and 0.95 leading with +3% to -5% frequency variation,			
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	terminal voltage variation of +/- 5% and combined voltage & frequency variation of 5%. It shall be ensured that when the Generator is working at this capability and design maximum secondary cooling water temperature (ECW temperature), no part of the Generator shall attain a temperature in excess of the temperature limits specified for Thermal Class 130 (B) insulation as per IEC-60034. Short Circuit Ratio of the generator shall not be less than 0.48. b) Also the generator and its excitation system shall be capable of continuous stable operation without any excessive temperature rise at the peak output of the associated steam turbine under VWO & HP heater out condition, etc. as available for design maximum secondary cooling water temperature (ECW temperature) at all power factors between 0.85 lagging and 0.95 leading with +3% to -5% frequency variation, terminal voltage variation of +/- 5% and combined voltage & frequency variation of 5%. Temperature of different parts may exceed those permissible for Thermal Class 130 (B) insulation under such operating conditions, but shall be lower than those permissible for Thermal Class 155 (F) insulation as per IEC-60034. c) Generator and its excitation system shall be capable of the flexible (Shift and Cyclic) modes of operation as per requirement of associated boiler and turbine systems specified elsewhere in the specification. d) For the Generator and its excitation system specific design features incorporated and design/process improvements which are being offered considering modes of operation as per Sub Section G-01 - Operating Capability of Plant - in Technical Specification shall be submitted within 4 weeks of award of contract. Such design features and design/process improvements over and above conventional design, results of design analysis are required to be submitted as part of the EIFS (Engineering information flow system).			
3.02.00	Generator Transformer The Generator Transformer shall comprise of bank of three (3) single phase GT's and shall have off circuit tap changer with the minimum range of +/- 5% with each step of 2.5%. The rating of the Generator Transformer shall be suitable for continuous stable operation of unit at the rated nominal output at all power factors between 0.85 lagging and 0.95 leading. The rating of each single phase GT shall be 315 MVA.			
3.03.00	Generator Busduct Isolated phase busduct, continuous, natural air cooled and positive pressure type, with enclosure of weather-proof, dust tight, non-magnetic minimum flux type. The continuous rating of the Generator busducts shall be such that the maximum continuous peak output of the steam turbine unit under VWO/ HP heater out condition etc. at any ambient temperature between 0 deg C and 50 deg. C can be delivered at the rated power factors and allowable generator voltage variations without exceeding the permissible temperature rise limits as specified for these equipment's.			
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3.04.02	b) MDBFP load for one unit plus c) Meeting the station loads distributed on the respective station boards plus d) Multiplied by no load voltage correction factor as defined at 3.04.00. <u>Case II: Outage of any one of the Station Transformer and all the connected loads on the set of Station boards are fed from other available Station transformer.</u> a) Meeting loads of one unit operating under HP-LP bypass mode plus b) MDBFP load for one unit plus c) Meeting full connected station auxiliary loads (on two sets of station boards as mentioned above) plus. d) Multiplied by no load voltage correction factor as defined at 3.04.00. The station load shall be distributed in such a manner that the two LV windings shall be equally rated. The HV winding rating of Station transformer shall be equal to the sum of LV winding ratings. While calculation the total station load during HP-LP Bypass condition, Single stream operation of CHP/AHP shall be considered.			
	Auxiliary Transformers Adequate number of auxiliary transformers shall be provided to meet the demand on 11KV, 3.3 KV and 415V systems under most onerous conditions, with the criteria that each 3.3KV /415 V switchgear / MCC / DB shall be fed by 2x100% or 3 X 50 % transformers /feeders or as per feeding arrangement as shown in tender SLD, and these shall be rated to carry the maximum load including owner’s load (if applicable) expected to be imposed. In case of ESP boards, a common standby transformer having rating equivalent to Main ESP load of one pass plus ESP AC & emergency etc. requirement, shall be provided for maximum of three ESP passes as indicated in the Aux Power Supply Drawing No 4540-999-POE-J- 001. Individual Transformer for CHP systems shall be sized to cater to load of single stream running in case of one feeder/transformer outage			
3.05.00	MV Switchgears a) The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free-standing floor mounted panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IEC 622771-200). The Circuit Breakers / Contactors / Bus VTs shall be mounted on withdraw able trucks which shall roll out horizontally from service position to isolated position. The Switchgear shall have an Internal Arc Classification of IAC FLR 40kA 1 sec. The Circuit Breakers / Contactors shall be of Vacuum type. b) All MV incomers from transformers and ties between switchgears shall be through bus ducts or adequately rated cables.11kV and 3.3 kV incomers from transformers to			
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switchgear and ties between switchgears shall be through bus ducts for main plant. In the offsite areas, MV incomers from transformers to switchgear & ties between switchgears shall be through bus ducts or adequately rated cables.

- c) The sizing Criteria for a Typical MV Switchboard shall be determined by the size of the transformer feeding the board. As a design Philosophy the Board continuous Current shall be selected as $(1.1) * (\text{Full load current at rated voltage on the Transformer's secondary})$ at 50 deg. C Ambient.
- d) The various outgoing feeders shall be Feeders for Motors, Auxiliary Transformers, Tie feeders and Supply feeders. While sizing the outgoing feeder the rating is calculated based on the following:
 Motor Feeder: $\text{kW Rating} / [\text{System Vol} * 1.732 * (\text{Eff}) * (\text{Pf})] * 1.1$ (at least)
 Transformer feeder: $\text{Transformer kVA} / \text{primary [Voltage} * 1.732] * 1.1$ (at least)
 Tie feeder: As per system requirement
 Incomer feeders: Generally same as the Board rating
 Bus Couplers: Generally, 2/3 of the Incomer Feeder rating.
- e) Standard MV Switchgear Modules and their Selection Criteria: feeders shall be categorized into standard Modules. The module defines the feeder type, Protections, Feeder schematics and metering and monitoring requirements. The Standard Modules are listed in table below:

S No	Module Type	Application	Applicability
1	DA	Motor Feeder	MV Motor Feeders < 2 MW
2	DAF	Motor Feeder with Differential Protections	MV Motor Feeders $\geq$ 2 MW
3	DB	Transformer Feeder	Transformer feeder < 5 MVA
4	DBF	Transformer Feeder with Differential Protections	Transformer feeder $\geq$ 5 MVA
5	DC	Incomer Feeder	MV Incomer Module
6	DD	Bus Coupler Feeder	Bus Coupler Module for MV Boards
7	DE	Tie Feeder	Unit-Station / Station-Station Tie
8	DE (Outgoing)	Tie Feeder	Outgoing feeders except to transformers

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3.06.00	9	CC/CCT	Contactor controlled Motor / Transformer	CHP MV Drives / Stacker-Reclaimer Transformers	
	10	DB1 (< 5MVA) DBF1 (> 5MVA)	Standalone Transformer feeders	Standalone panels with both incoming & outgoing cables for remote locations	
	LV Switchgears				
	a) All switchboards shall be of double front, draw out, complete closed-door operation, metal enclosed, indoor, floor-mounted, free-standing type of bolted design. Entire bus bar system shall be insulated with PVC sleeves (UL 224). Cable terminations located in cable alley shall be designed to meet the Form IVb (as per IEC 60439) for safety purpose. Soot blower MCC/switchboard (with IP 55 protection) on the boiler platform shall be acceptable.				
	b) All ACDBs, DCDBs, Solenoid Valve DBs and MCCs located on Stacker Reclaimer, Paddle feeders and Travelling trippers shall be of Fixed Module type. All 415V Circuit breaker modules and other MCC modules shall be fully draw out type.				
	c) The Circuit Breakers / Contactors shall be of air break type & should conform to the requirements of IS / IEC 60947.				
	d) MCCB shall be provided for all supply feeders of current rating upto and including 400A. Air circuit breakers shall be provided for supply feeders above 400 Amps.				
	e) For protection of motors below 30kW, MPCB(only Short-circuit release) and Intelligent motor controller(IMC) with current sensing module shall be provided and for motors from 30kW and below 90kW, MCCB and Intelligent motor controller(IMC) with current & voltage sensing module shall be provided. Motor feeders below 90kW (up to 160kW for CHP conveyor motors) shall be contactor controlled. Contactors shall be of 250% of motor FLC for fan and compressor application and 200% of motor FLC for other application. The motor feeders for 90kW & above shall be Air Circuit Breaker controlled.				
	MOTOR FEEDERS BELOW 90KW SHALL BE CONTACTOR CONTROLLED. THE MOTOR FEEDERS FOR 90KW & ABOVE SHALL BE AIR CIRCUIT BREAKER CONTROLLED.				
	f) For 415V system, busduct assemblies shall be provided for incoming connection from transformers to the switchboard and interconnecting sections between switchboards wherever transformer rating is 1000KVA or above.				
g) The sizing of LV boards shall be dependent on conditions such as total load connected to a board, diversity factors for various loads connected, Fault Level and Voltage Regulation Considerations, etc.					
h) As far as practicable the system shall provide segregated supplies to main and standby auxiliaries so that the failure of supply to main auxiliary shall in no way jeopardize the standby auxiliary feed. Automatic changeover at critical switchgear / MCC sections shall be provided as necessary to prevent the loss of a unit or to ensure the equipment safety.					
i) All indoor floor mounted switchgear (PCCs/MCCs), ACDBs of busbar rating more than or equal to 100 A and DCDBs shall require to qualify the Sub-QR clause of LT switchgear.					
j) Sizing of LT boards					
a) Input kVA for a Drive = (Rating in kW X Load Factor) / (Efficiency X Power Factor) where values of load factor, power factor and efficiency are defined below:					
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	Load (service) factor for 415 V loads is taken as 0.85 for continuous and 0.1 for intermittent loads. Power factor 415 V Uni-Directional drives is taken as 0.8 and efficiency as per IS:12615, Premium Efficiency Class-3. Power factor of 415 V bidirectional drive loads is taken as 0.65 and efficiency as 0.8 for motor rating less than 15 kW. For motor ratings of 15 kW and above the corresponding values are 0.75 and Efficiency as per IS:12615, Premium Efficiency Class-3. b) The Finally selected Busbar ratings for Switchboards, MCCs, ACDBs and Busducts shall include a 10% margin over the calculated values. c) Lighting load shall be considered with a service factor of 70% of the associated lighting transformer size, on each section of main switchgears with incomer from transformer. d) Busbar Ratings of Valve / Damper ACDBs shall be derived by addition of 5% of the total kVA load connected and the rating of the largest Valve / Damper connected. e) Welding sockets shall be connected from Welding DBs, which shall be fed through 1X100% Welding transformers. f) ESP consumption for 100% BMCR operation shall be considered and further this load shall be uniformly divided among main ESP Switchgears. k) Sizing of Offsite Boards 1. The loads for mechanical auxiliary systems shall be met by auxiliary transformers based on the criteria that each switchgear/MCC/Distribution board shall be fed either by 2x100% or 3x50% transformers/feeders and, these shall be rated to carry the maximum load expected to be imposed. Each of the above boards shall be sectionalized. 2. The sizing of Unit Emergency boards shall be in according to the DG rating. The Emergency board shall have tie to both sections of Unit Service Switchgear for catering unit loads in Blackout Conditions. 3. For Main Plant (TG & SG areas), each Lighting DB shall have 1X100% transformer. For all other offsite areas, each Lighting DB shall have 2X100% transformers. l) Layout Criteria The switchboards can be split into two sections based on layout constraints in case of long switchboards to optimize Switchgear room layouts. The two sections of the split shall be connected by Busduct / Cable as per layout requirements. m) Spare capacity and Future Requirements All LV Switchboards shall be provided with spare feeders / mod-ules as specified in relevant clause of Part-A of Technical Specification			
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3.07.00	n) Standardization It shall be preferred to have all LV Switchboards for the entire plant from One / Two manufacturer(s) from maintainability and spares management point of view. It shall be preferred to follow a standardization of Terminal Numbers across all LV Modules for ease of Interconnection and maintenance. o) Plant control cable Interconnections Control cable interconnections between switchgears and transformer marshalling boxes, switchgears and motor terminal boxes / push button stations, and between various switchgears shall be in the contractor's scope. a) Standard control cable sizes shall preferably be 3CX1.5, 5CX1.5, 7CX1.5 & 10CX1.5 mm² b) Cable size for motor space heater application shall be 2CX2.5 mm² c) Interconnections for Current Transformer terminals shall use two cores of 1.5mm² size per phase d) Core identification shall be using core color for up to 5-core cable and core number for cable with more than 5 cores. e) Separate control cables shall be used for current transformers f) Spare core shall be made available in each of the control cable as mentioned in technical specifications Part-B- Chapter-10. g) 19Cx1.5 Sq.mm Control cable is also acceptable on case-to-case requirement only.			
	Numerical Relay Networking The Numerical Relay Network system shall be an integrated system for protection, control (except motor feeders), measurement and monitoring of all MV & LV circuit breakers / vacuum contactors in the Auxiliary Power Supply network. The system shall have communicable numerical relays complying with IEC-61850 on all feeders which shall be networked on Ethernet to form a distributed dual ring architecture to be connected to DDCIMS for monitoring & data acquisition of all MV & LV circuit breakers/ MV vacuum contactors on IEC 61850 protocol. The circuit breaker will normally be controlled from remote control panels (DDCMIS) through closing and shunt trip coils. All the protective relays associated with the Circuit breaker modules shall be of Numerical communicable type for Protection, Control, Metering and Status monitoring. All ther numerical relays shall have communications on three ports local front port communication to laptop and dual ports on IEC 61850to communicate with the DCS through LAN. The auxiliary contacts of the ACB/VCB shall be fed to the digital inputs available in the numerical relays of Incomer / bus coupler / motor circuit breaker feeders or 61850 Compatible IO Modules, for integration into the numerical relay network/ DCS. Control Philosophy			
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3.08.00	The Design Philosophy shall be as follows: (a) All the 11 KV/ 3.3 KV & LT Incomers, Bus Ties, Bus couplers, Transformer Breaker feeders shall be controlled from DDCMIS through hard-wired interlocks & Close/Trip commands. (b) All MV breaker/Vacuum contactor controlled, and LT Breaker controlled motor feeders shall be controlled from the DDCMIS through hard-wired interlocks & Close/Trip commands. (c) All LT Contactor controlled motor/heater feeders shall be controlled from DDCMIS through Intelligent Motor Controller (IMC) on profibus DP communication. (d) Bus transfers for 11KV station to unit shall be provided with fast bus, In phase and slow changeovers to ensure Bump less and Safe and Speedy BUS transfers and to avoid unit trips during bus transfers. Bus transfers for unit 3.3KV systems shall be provided with In phase and slow changeovers to ensure Bump less and Safe BUS transfers to avoid unit trips during bus transfers.			
	Cables and Bus Ducts The minimum rating of cable/ bus ducts shall meet the following criteria: All the cables and bus ducts feeding switchboards from transformers shall be sized based on transformer rating. All the cables and bus ducts feeding transformers shall be sized based on current ratings of transformer at the minimum voltage tap of the transformer. All other cables/bus-ducts shall be sized based on the load demand under most onerous conditions. Cables shall be selected so as to limit maximum voltage drop at equipment terminals during normal operation and starting conditions well within permissible values. Cables shall be derated for the site ambient and ground temperatures, grouping and soil resistivity and cable laying configuration. All HT cables shall be of unearthed grade. Bidder shall furnish detailed cable selection/sizing criteria for Employer’s approval.			
	Earthing & Lightning Protection System The earthing system for plant shall be designed for a life expectancy of at least forty (40) years, for a system fault current of 50 kA for 1.0 sec. The minimum rate of corrosion of steel (over calculated diameter) for selection of earthing conductor shall be 0.12mm per year. Grounding and lightning protection for the entire power plant, switchyard and other areas or buildings covered in the specification shall be provided in accordance with IS 3043, IEC 62305, IEEE 80 and IEEE 665.			
3.10.00	D.C. Systems			
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CLAUSE NO.

TECHNICAL REQUIREMENTS

Complete DC system, comprising of batteries, battery charges, relays, contactors, timers etc. shall be suitable for continuous operation at the maximum continuous float voltage including suitable temperature correction factors.

The battery sizing shall be done based on different types of continuous and intermittent loads including motor starting (wherever applicable) under complete blackout condition, for the duration specified so as to meet the system requirement. The total DC load shall include load for Employer's facilities also (if applicable), as identified in the scope given at Section-VI, Part-A Sub Section-IIB. All intermittent loads shall be considered with minimum 1 minute duration. Nameplate ratings of DC motors shall be used in sizing.

The battery shall be sized considering a minimum electrolyte temperature of 15°C along with temperature correction factors as per relevant standard. An ageing factor of 1.25 shall be considered for Ni-cd only. The no. of cells, end cell voltage shall be considered based on the minimum and maximum voltage window and cable drop etc. as per system requirement.

Each system shall comprise of two nos. of batteries and two nos. of float-cum-boost chargers each rated for 100% capacity. DC scheme shall ensure that each critical consumer is fed from two different bus sections. DCDBs shall provide adequate number of feeders on each section.

Boost/ fast charging time shall be as per worst operating condition and would satisfy technical requirements recommended by battery manufacturer. Each battery charger must be capable of supplying all the continuous D.C. loads (fed through both section of DCDB) plus the trickle charging current of both the batteries. In addition, each charger must have sufficient surplus capacity for running of the largest D.C auxiliary so that the battery is not drained during testing of the same. Battery charger should also be capable of boost/ fast charge the battery from completely discharged condition to fully charged condition without imposing any limitations under worse operating conditions.

The various DC Systems envisaged along with minimum battery bank ratings to be adopted are indicated in the following table. Bidder may supply additional DC systems at offsite load centers as per system requirement:

Area	DC Voltage	Load	Minimum Battery Bank Rating
Unit	220 V	Total DC load of the unit at an acceptable voltage for at least 30 minutes	As per system requirement
CHP	220 V	Total CHP DC load at an acceptable voltage for at least 30 minutes and DC lighting for at least one hour	150AH for lead acid Plante type /90 AH for Ni-Cd High Discharge (KPH) type batteries
Ash silos/CT/CW PH etc.	220 V/ 110 V	supply total DC load of the associated area at an acceptable voltage for at least 30 minutes	150AH for lead acid Plante type /90 AH for Ni-Cd High Discharge (KPH)



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3.11.00	switchyard	220 V batteries	(a) Emergency lighting in Switchyard control room for a period of 1 hour plus (b) All continuous DC loads of relay & control panels for a duration of 3 hours plus (c) Interlocking coils of isolators/earth switches shall be considered including requirement of three future line bays for a duration of 3 hours plus (d) loads in worst of the following conditions (i) simultaneous operation of the maximum number of breakers & associated equipment's in case of bus fault in the switchyard. (ii) Operation of Breaker failure relay (LBB relay)	type batteries 625AH lead acid Plante type/410 AH Ni-Cd (KPH type)	
	DC Health Monitoring Systems for Main Plant (220 V) and switchyard (220V) shall be provided to monitor the condition of each battery cell of 220V battery banks on-line on 24x7 basis. With DC Health Monitoring System, it shall be possible to measure & analyze the individual cell and battery parameters so that any damage to battery shall be prevented by pro-active maintenance. The location of cell monitoring systems shall be away from the battery bank. All the cards used for BHMS system shall have conformal coating. Diesel Generator Set For safe shut down of the plant under emergency condition and in case of total power failure, one Diesel Generating set per unit shall be provided. Each DG set shall be capable of meeting 100 % of essential load requirements of one generating unit without exceeding the permissible running voltage drop. Additionally, it shall be possible to start the largest rating motor connected to emergency switchgear at 50% prestart loading condition without exceeding the permissible starting voltage drop criteria. Some of the vital station auxiliaries/systems like battery chargers of switchyard, auxiliary supplies of instrument/plant air compressors, emergency air conditioning and ventilation system loads shall also be fed from DG set supply. The emergency air conditioning and ventilation system requirements pertaining only to the Main Plant areas (like Control Room, Control equipment Room, SWAS Room, UPS Room) shall only be provided the DG backup. Auxiliary supply of Plant and service air compressors shall also be fed from emergency supply. During Grid black-out condition, it shall be ensured that only the essential auxiliaries of the unit are fed from Diesel generator & non- essential loads are automatically tripped.				
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	In addition to above DG sets, one standby DG set with rating identical to Main DG set shall also be provided, as a backup, to cater the load requirements of the unit at a time. Bus Trunking systems shall be used to connect DG set to Emergency Switchgears and Standby DG sets. In addition to above main plant DG sets, One number DG set shall be provided for catering to emergency loads in FGD area also. For FGD, Diesel Generating set(s) shall be provided as per system requirement for safe shut down of the FGD system/plant under emergency conditions and in case of total power failure to FGD system. The DG set shall be capable of starting largest size of emergency 415 V drive (motor) having starting kVA/ rated kW ratio of 8 (higher if starting current is more than 8) and starting power factor of 0.2 with terminal voltage drop being restricted to 15%. Generator loading before starting of this motor shall be considered as 50% of generator rating.																																												
4.00.00	ISLANDING SCHEME The plant shall be designed to operate in islanding mode of operation by tripping all the lines and generators except for one pre-selected unit, which shall run with the available plant load under such condition.																																												
5.00.00	PLC based control system wherever envisaged shall be provided with 100% redundancy i.e. hot standby.																																												
6.00.00	INSULATION LEVEL The insulation level for the transformer windings and bushings shall be as follows: <table><thead><tr><th></th><th colspan="2">WINDING</th><th colspan="2">BUSHING</th></tr><tr><th>Highest System Voltage</th><th>Rated Power Freq. withstand Voltage (kVrms)</th><th>Rated lightning impulse withstand voltage (kVp)</th><th>Rated Power freq. withstand voltage (kV rms)</th><th>Rated lightning impulse withstand voltage (kVp)</th></tr></thead><tbody><tr><td>0.433 KV</td><td>3</td><td>-</td><td>3</td><td>-</td></tr><tr><td>3.6 kV</td><td>10</td><td>40</td><td>11</td><td>40</td></tr><tr><td>7.2 kV</td><td>20</td><td>60</td><td>22</td><td>60</td></tr><tr><td>12 kV</td><td>28</td><td>75</td><td>30</td><td>75</td></tr><tr><td>17.5 kV</td><td>38</td><td>95</td><td>42</td><td>95</td></tr><tr><td>24kV</td><td>50</td><td>125</td><td>55</td><td>125</td></tr></tbody></table>						WINDING		BUSHING		Highest System Voltage	Rated Power Freq. withstand Voltage (kVrms)	Rated lightning impulse withstand voltage (kVp)	Rated Power freq. withstand voltage (kV rms)	Rated lightning impulse withstand voltage (kVp)	0.433 KV	3	-	3	-	3.6 kV	10	40	11	40	7.2 kV	20	60	22	60	12 kV	28	75	30	75	17.5 kV	38	95	42	95	24kV	50	125	55	125
	WINDING		BUSHING																																										
Highest System Voltage	Rated Power Freq. withstand Voltage (kVrms)	Rated lightning impulse withstand voltage (kVp)	Rated Power freq. withstand voltage (kV rms)	Rated lightning impulse withstand voltage (kVp)																																									
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	36kV	70	170	77	170	
	72.5 kV	140	325	155	325	
	145kV	275/38*	650	305	650	
	245 kV	395/38*	950/1050**	505	1050/1050**	
	420 kV	630/38*	1425/1570**	750	1550/1570***	
	Switching Impulse withstand voltage, (kVp)					
	400 kV	1175kVp				
	* In case of non-uniformly insulated. ** Chopped wave BIL.					
	*** Suitable for chopped wave impulse test on transformers.					
7.00.00	NEUTRAL GROUNDING					
7.01.00	Neutral earthing equipment shall be designed duly taking into account the maximum permissible operating voltage of the generator, voltage rise on load throw off (subsequent to detection of earth fault) field suppression time, ferro-resonance, etc. The generator shall be grounded through distribution transformer with secondary loading resistor, limiting the earth fault current to not less than capacitive current so as to restrict the over voltages caused due to capacitive currents. The neutral earthing equipment shall be rated to carry this current for at least 5 minutes considering the Generator Terminal Voltage under maximum field forcing conditions.					
7.02.00	11KV/3.3KV system earthing shall be low resistance earthed type to limit earth fault current to 600A. The resistor shall be rated to carry this current at least for 10 seconds.					
7.03.00	Neutrals of Generator Transformers (on 400kV side), and LV Side of all LT Transformers (415V) shall be solidly earthed through bolted links.					
7.04.00	220V DC system shall be kept ungrounded.					
7.05.00	Diesel generator shall also be kept ungrounded (earthing through PT).					
8.00.00	FAULT LEVEL					
	Equipment through fault withstand capabilities under worst operating conditions duly taking into account negative tolerances on transformer, generator & maximum fault levels of source etc. shall be as follows :					
	i) a) Generator Transformer, Station transformer -	3 seconds (** Please See Note)				
	b) Unit transformer					
	In case of Station Transformer Scheme	- 8 seconds (** Please See Note)				
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	ii)	All other transformers	- 2 seconds	
	iii)	Generator busduct main run (higher of generator or EHV system & motor fault contribution)	- 1 second	
	iv)	Delta and tap off run busduct (sum of generator, EHV and motor contribution through UT)	- 1 second	
	v)	11 kV busduct	- 1 second	
	vi)	Switchgears	- 1 second	
	vii)	Cables to the feeders protected by breakers	Main protection fault clearing time with 0.12 second minimum	
	viii)	Cables of all other feeders	As per MCCB operating time	
	ix)	11KV & 3.3KV cable screen	- 2 seconds for the adopted ground fault current	
	x)	EHV systems	- 1 second	
		(** Note) Thermal withstand design time duration. The indicated values of time durations are used in transformer design for ensuring thermal stability of the transformers and are to be proven through calculations.		
9.00.00	MOTORS			
	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for ID and MDBFP Motors:			
	(a)From 50KW & upto 110KW : 11.0			
	(b)From 110 KW & upto 200 KW: 9.0			
	(c)Above 200 KW & upto 1000KW : 10.0			
	(d)From 1001KW & upto 4000KW : 9.0			
	(e) Above 4000KW : 6 to 6.5			
	Starting voltage requirement :permissible starting voltage for motor shall be as follows:			
	(a) Up to 85% of rated voltage for ratings below 110 KW			
	(b)Up to 80% of rated voltage for ratings from 110 KW to 200 KW			
	(c)Up to 85% of rated voltage for ratings from 201 KW to 1000 KW			
	(d)Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(e)Up to 75 % of rated voltage for ratings above 4000KW Note : Minimum starting voltage for double cage induction motor (only for Mill application) shall be 85%RV. Bidder has to submit the necessary voltage drop calculations for verification.			
10.00.00	All the plant and equipment's/systems supplied under the contract shall be designed following "Fail Safe" concept in case of failure of Power Supply like Electric Power, Hydraulic pressure, Pneumatic pressure, Vacuum etc the system shall be designed in such a way that the equipment shall always move/remains (as applicable) to safest position as per system requirement to ensure safety of Man and Machinery.			
11.00.00	Latest Cybersecurity guidelines laid down by CEA/Government of India shall be followed.			
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SUB-SECTION-B – 01

GENERATOR AND AUXILIARIES

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	GENERATOR & AUXILIARIES			
1.00.00	GENERAL REQUIREMENTS			
1.01.00	This chapter has to be read in conjunction with sub-section B-0"general electrical specification" of Technical specification Section-VI, Part-B and Sub-Section IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A.			
1.02.00	All equipment shall be suitable for rated frequency of 50Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.			
1.03.00	Contractor shall provide fully compatible electrical system, equipment, accessories and services.			
1.04.00	Standard	:	IEC-60034 IEEE1129, IEEE115	
1.05.00	NOT USED			
1.06.00	All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.			
2.00.00	TYPE AND RATING			
2.01.00	Type : Three phase, horizontal mounted, indoor installed, two-pole, Thermal Class 155 (F) winding insulation, Stator water/Hydrogen cooled, cylindrical hydrogen / water cooled rotor type.			
2.02.00	GENERATOR RATING			
2.02.01	Generator and its excitation system shall have a capability at least matching the declared maximum continuous rated output of the associated steam turbine (for the designed secondary cooling water temperature) at all power factors between 0.85 lagging and 0.95 leading with +3% to -5% frequency variation, terminal voltage variation of +/- 5% and combined voltage & frequency variation of 5%. It shall be ensured that when the Generator is working at this capability and designed cooling water temperature, no part of the Generator shall attain a temperature in excess of the temperature limits specified for Thermal Class 130 (B) insulation as per IEC-60034.			
2.02.02	Also the generator and its excitation system shall be capable of continuous stable operation without any excessive temperature rise at the peak output of the associated steam turbine under VWO & HP heater out condition, etc. as available for the designed secondary cooling water temperature, at all power factors between 0.85 lagging and 0.95 leading with +3% to -5% frequency variation, terminal voltage variation of +/- 5% and combined voltage & frequency variation of 5%. Temperature of different parts may exceed those permissible for Thermal Class 130 (B) insulation under such operating conditions but shall be lower than those permissible for Thermal Class 155 (F) insulation as per IEC-60034.			
	Refer chapter B0 for ratings of the Generator.			
2.02.03	Rated Parameters:			
	1.	Power Factor	0.85 (lagging)	
	2.	Terminal voltage	In the range of 18 TO 28KV	
	3.	Frequency	50 Hz	
	4.	Speed	3000 rpm	
	5.	Short circuit ratio	Not less than 0.48(without negative tolerance)	
3.00.00	SYSTEM OF COOLING			
	1.	Stator winding	Closed loop system using Hydrogen or using demineralised water flowing through the hollow conductors.	
	2.	Rotor winding	Directly cooled by hydrogen, Alternatively Manufacturer's standard & proven arrangement of Rotor cooling with water is also acceptable. Contractor shall furnish complete details of water cooling system alongwith the bid.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
4.00.00 5.00.00	3.	Stator core	By hydrogen flowing through suitable ventilating ducts or water cooled.		
	4.	Configuration for Hydrogen Cooling	Shaft driven Hydrogen blower and machine mounted Hydrogen to water heat exchanger.		
	5.	Capacity with one Gas Cooler/ Cooler section out	Capable of delivering at least two third of the rated and max. continuous MVA with one cooler/cooler section out of service and ten (10) percent of tubes plugged in remaining coolers that are in service without exceeding the temperature limits of Thermal Class 130 (B) and Thermal Class 155 (F) respectively.		
	INSULATION:		Thermal class 155 (F) for Stator and Rotor winding		
	OPERATIONAL REQUIREMENTS FOR GENERATOR				
	1.	Voltage Variation	+/-5% continuously at rated power factor. Reduced MVA operation at 110% of the rated Voltage. (to be indicated by the Contractor)		
	2.	Frequency Variation	47.5 HZ to 51.5 Hz.		
	3.	Combined voltage and frequency variation	5%		
	4.	Power factor variation	0.85 (lag) to 0.95 (lead)		
	5.	Operation under unbalanced Load	As specified in IEC 60034-1		
	6.	Operation under unsymmetrical short circuit	Negative sequence current I_2 expressed in per unit of rated current for a duration of 't' second such that the value of I_2^2t shall comply to IEC 60034-1		
	7.	Voltage Wave form	The Total Harmonic Distortion (T.H.D) shall be within the limit specified in IEC 60034-1.		
8.	Short Circuit withstanding capacity	Capable of withstanding of 3 phase short circuit at the generator terminals when operating at rated MVA and power factor with 5 % over voltage for a period of not less that 3 seconds.			
9.	Special operating conditions	Capable of withstanding the electrical, mechanical and thermal stresses developed during fast reclosing of high voltage line, transmission line switching, faults, out of step operation and out of phase synchronisation etc.			
10.	Line Charging Capability	Not less than 30% of its rated MVA at zero pf.			
11.	Generator Neutral Earthing	Non-effectively earthed through a distribution transformer, loaded with a resistor. The core design to permit the flow of earth fault current of at least 15 amperes for one (1) second without major core damage			
12.	Impulse level & Surge Protection	To be suitable for test voltage of 4U+5 KV. (where U is rated line to line voltage in KV). Lightning arrestor surge arrestor andsurge capacitor of suitable rating shall be provided for the protection of generator winding.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
6.00.00	DESIGN AND CONSTRUCTIONAL FEATURES 1) General a) All components of the generator to be designed to avoid resonance at any of the frequency in the operating range and their multiples. b) All components requiring inspection and maintenance to be designed for easy access and replacement. 2) Stator Body a) Enclosure To withstand without any residual deformation, any internal hydrogen explosion. b) Handling Four number of trunions to be provided for handling the stator by means of crane. The Contractor to clearly bring out in the proposal the features provided in the generator body construction to enable generator stator to be lifted/dragged in case of non-availability of suitable crane. c) Transportation The dimensions of the generator stator body to be within the maximum permissible rail / road transportation dimensions within the country taking into account the special wagons available/being made available for transporting such heavy over sized consignment. d) Manholes At suitable locations with proper sealing arrangements etc. to facilitate the inspection of back of the core, end winding area and terminal connections. 3) Stator Core a) Material High permeability, low loss, cold rolled silicon sheet steel segmental punching. b) Core assembly Assembled on core bars in an interleaved manner. To rest on flexible support system such that radial and tangential magnetic vibration of the stator core due to electromagnetic loading transmitted to the outer frame is minimum. c) End packets To be adequately strengthened to minimise the magnetic vibration due to end leakage flux. 4) Stator Winding a) Winding The stator winding shall consist of three phase, Configuration double layer, short chording, bar type winding having two parallel paths. The elementary conductors shall be Roebel transposed in the slot portion. b) Winding Insulation Epoxy thermo-setting type and rated for Thermal Class155 (F) insulation. Adequate semiconducting protection shall be provided on the winding and slots to avoid Partial Discharges. c) Ripple springs To be provided in stator slots. However Contractor's standard and proven arrangement of conductor support shall be accepted. d) End windings Fastening elements used in generator shall be non - magnetic & shall be used with proper locking arrangement. 5) Distillate Headers (wherever applicable) a) Inlet and outlet water headers Stainless steel b) Insulation The headers and header connections shall preferably be insulated from the stator body.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	c) Connection of bars High quality heat resistant and high strength Teflon(P.T.F.E) hoses. Single pass cooling arrangement shall be preferred. 6) Winding Connection and Terminal Bushings a) Winding Star connected. Three (3) phase and the three (3) neutral terminals brought out. In case the stator winding is double-star, a machine with six (6) or nine (9) terminals will be acceptable. All stator terminal lead connections inside the generator shall be suitably supported to contain vibration. b) Overhang Portion of winding The over hang portion of the winding shall be suitably braced and supported so as to withstand - 3 phase short circuit at its terminals as stipulated in IEC-60034 when the machine is operating at rated MVA, power factor and permissible maximum over voltage. c) Bushing housing Bushing to be housed in stator frame in a non magnetic steel terminal box. However Contractor's standard and proven arrangement shall be accepted. d) Bushing Porcelain or epoxy based material with non-hygroscopic property. The terminal bushing shall be cooled by suitable arrangement with cooling medium/system envisaged for the generator. e) Terminal connector Silver coated copper as per standard and proven design of the bidder, suitably designed for temperature rise of 55 deg C at rated current for connection to the busduct through flexible. The Terminal connector shall be designed so as to have adequate clearance between faces to sustain forces arising out of three phase sudden short circuit 7) Rotor Machined from a single alloy steel forging to give the required mechanical, metallurgical and magnetic characteristics. Rotor shall have an adequate margin between critical speed and the operating range of speed to ensure smooth running. 8) Rotor Winding a) Conductor Coils made of hard drawn silver bearing copper. b) Insulation Epoxy glass based material rated for Thermal Class 155 (F) insulation. 9) Retaining Rings and Nuts a) Retaining rings The retaining ring shall be provided to prevent the movement of rotor winding in the radial/ axial direction due to centrifugal/ thermal stresses. Retaining ring shall be machined from high strength, non-magnetic alloy steel forging, with broad material specification of 18Mn-18Cr, resistant to stress corrosion. Floating type shrunk on the rotor body. b) Locking nuts/ snap rings: High strength non-magnetic alloy steel forging shall be provided on the retaining rings to prevent any axial movement. However Contractors standard and proven arrangement of locking the retaining rings shall be accepted. c) Centering rings To be mounted at the end of the retaining rings to support it in position		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	pressure, temperature and flow gauges as well as thermostats as required. However Contractor's standard and proven system of generator drying arrangement is also acceptable. 15) Generator Instrumentation The following minimum instruments shall be provided for each generator. For the requirements regarding type, make etc. of instruments and sensors, refer stipulations under relevant Sub-sections of Control & Instrumentation. A) Resistance temperature detectors (RTD) a) Temperature Detectors Resistance temperature detectors (RTD) to be duplex four / three wire type 100 ohms platinum, calibrated as per DIN standard and located at points where highest temperature is likely to occur during operation. The bidder may also offer thermo-couple (TC) or duplex RTDs. In case simplex RTDs are provided they shall be double in quantity of those specified as below. b) Number and location i) Atleast Twelve (12) detectors, four per phase and uniformly distributed along the circumference of the stator and located at the hottest possible zones. viz. the point of exit of stator water from winding in a water cooled machine. Preferably all stator slot temperatures shall be measured. ii) Detectors (One no of Simplex or Duplex) for monitoring water temperature of each winding bar in case of water cooled machine. Alternatively, monitoring water temperature of converged water flow of top and bottom bar of each slot using thermocouple / detector(One no of Simplex or Duplex) shall also be acceptable. iii) Twelve (12) detectors for stator core out of which four (4) shall be located in the end zones where maximum temperatures are expected. iv) Two (2) detectors per H2 gas cooler section for measurement of inlet and outlet gas temperature. v) Two (2) detectors per H2 gas cooler section for measurement of inlet and outlet water temperature. vi) Two (2) detectors per bearing for measurement of babbitt metal and drain oil temperature. vii) Sets of detectors for generator shaft sealing, Hydrogen gas and stator water systems required for monitoring the temperature of oil, water and Hydrogen at different salient locations in the system. c) Termination of RTD leads At terminal box after grouping of signals. d) Location Terminal box for RTD's shall be at an easily accessible position so as to enable maintenance/testing of the devices when the machine is under operation. e) Terminal box construction Dust and vermin proof (IP54) f) Interface All the above temperature measurement devices shall be connected to DDCMIS. B) Termination Arrangement All the instrumentation wiring coming out of the Generator shall be routed through a common terminal plate with suitable sealing arrangement. However bidder's standard and proven termination arrangement shall be accepted.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
7.00.00	C) Rotor winding Temperature measurement and monitoring	To be monitored in DDCMIS.		
	D) On line water temperature Monitoring for Individual stator winding bars (Applicable for water system)	Complete with all software and hardware required to detect any abnormalities in the temperature at any given generator operating point and shall be sensitive to generator loads, header flows, pressure, etc. This shall be realised in DDCMIS.		
	E) Vibration monitoring System	At least six (6) numbers of dual axis optical sensor type vibration pickups at each end of over hang portion of the winding shall be provided, symmetrically located around the periphery with connection to Turbine Supervisory system for vibration monitoring and trend recording. Suitable connection between the pickups and Turbine Supervisory system for vibration monitoring shall be provided. Also a standalone system for the vibration monitoring system is also acceptable.		
	F) Liquid leakage detector	Shall be provided at all the low level points inside the generator casing including end shields along with provisions of indication and alarm during leakage of liquid in generator in case of water cooled machine.		
	G) Rotor flux monitoring system:	Permanently connected independent sensing unit for each Generator shall be provided along with necessary terminal equipment to detect turn to turn shorting in field winding of Generator. It shall also be suitably connected to TG MMI to facilitate alarm. Also a standalone system for the Rotor flux monitoring system is also acceptable		
	GAS SYSTEM (FOR HYDROGEN & WATER COOLED MACHINES)			
	1) Description	Each generator shall be furnished with hydrogen and carbon dioxide supply system including hydrogen and CO2 gas manifold, CO2 heating system, gas cylinders, hydrogen pressure regulator, interconnecting piping, fittings, valves, gauges, thermometers, pressure transmitters and other instruments, control panels, etc.		
	2) Number of gas cylinders	Equal to total requirement of Hydrogen cylinders and CO2 Cylinders for one start up and number of CO2 cylinders required for shut down of a unit plus those required to be connected on manifolds of all units plus total requirements for seven days consumption of all units. The total CO2 cylinders shall be supplied duly filled up, however hydrogen cylinders are to be supplied in empty condition.		
	3) Purity	Purity of hydrogen from 97-99%.		
	4) Piping & Valves	Seamless steel tubes shall be used for valve piping. Valves shall be of glandless diaphragm type, wherever possible.		
	5) Purging	During purging, filling and emergency operating conditions, the gases shall be expelled to the atmosphere (outside the TG hall) through a manually operated vent valve.		
	6) Hydrogen Safety relief valve	To be provided at hydrogen manifold		
	7) Driers	2x100% duty to maintain the hydrogen inside the machine dry with zero deg C dew point at operating pressure. Type: Refrigeration type Drier shall be provided with stainless steel piping.		
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	8) Gas circulation at Standstill A suitable hot air blowing system complete with during long shut down blower, heater and thermostatic control etc. shall be provided to prevent condensation during long shut down. However Contractor's standard and proven system of generator drying arrangement during long shutdown is also acceptable. 9) Valve interlocking Three-way valve for interconnecting the hydrogen and carbon dioxide line (as applicable) shall preferably have mechanical interlocking such that closing of the hydrogen side port is positively ensured before opening of the air side port. 10) Online dew point On line dew point monitoring system with measurement with necessary isolation valves shall be provided across the inlet and outlet lines to the drying system alongwith alarm/annunciation in case of high moisture content in the generator casing hydrogen. 11) Nitrogen capping During the transportation and storage the machine shall be kept under nitrogen atmosphere. Contractor shall bring out the requirement of nitrogen gas during the normal operation. The complete nitrogen system as applicable along with the necessary nitrogen cylinders shall be furnished for each machine. However Contractor's standard and proven system to prevent ingress of moisture during transportation and storage shall be acceptable. 12) Gas Analyser Thermal conductivity / Density type shall continuously analyses the gas discharged from the casing during purging and shall also analyses samples of the casing hydrogen during normal operation. The analyzer shall measure the gas purity under the following three conditions: a) Normal % of purity of Hydrogen in the generator casing. Purity range shall include a low purity alarm. b) % of Hydrogen in CO₂ leaving the casing when Hydrogen is being admitted or expelled. c) % of air in CO₂ leaving the casing when CO₂ is being admitted or expelled. 13) The local Generator auxiliary panel (located at 0.0m) shall be complete with all lamps, indicators, power supplies etc. Further following instruments shall be provided. i) Pressure indicator / local gauge for gas pressure inside the generator. ii) Gas purity indicator. iii) Temperature indicator for cold hydrogen inside casing. iv) Dew point indicator for casing hydrogen across drier inlet and outlet lines 14) Alarms in TG MMI and i) Hydrogen pressure in generator casing Low/annunciation contacts for High. use in station DDCMIS shall be provided for ii) Hydrogen pressure in hydrogen cylinders-Low these conditions iii) Pressure of cooling water hydrogen coolers Low/High. iv) Purity of hydrogen in generator casing-Low. iv) Liquid level in the generator casing - High. vi) Temperature of cold/hot gas in the generator - High.		
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8.00.00		vii)	Dew point level, in hydrogen gas across the drier inlet and outlet lines - High.	
	15)	Portable gas analyser	Similar as detailed above under clause "Gas Analyser" shall be provided for supervision of the gas purging operation.	
	16)	Hydrogen pressure and Purity	To be monitored and annunciated in TG MMI.	
	SEAL OIL SYSTEM (FOR H2 / WATER COOLED MACHINES)			
	a)	General	A complete seal oil supply and control system including AC and DC motor operated pump sets, cooler (as applicable), filters, pressure regulators, oil tanks, de-gasification tanks, regulating and control valves, gauges, thermometers and other instruments, interconnecting piping including hangers and supports, valves and control panel complete with all interlocking relays shall be provided. Blowers for venting out Hydrogen gas liberated from oil shall be provided suitably mounted at places where such gas accumulation is likely to occur.	
	b)	Number of pumps	Two (2) number 100% AC motor driven pumps. One (1) number 100% DC motor driven pump.	
	c)	Pump starting interlock	The auto starting of standby seal oil pumps shall be interlocked with seal oil pressure.	
	d)	Emergency condition	During short time emergency which may arise due to non availability of both AC & DC pumps, unit may be tripped and seal oil supply for such coasting down period shall be from a suitable arrangement from lubrication oil system or a damper tank. Alternatively, standard and proven practice of bidder regarding connection between seal oil system and lubrication oil system/ damper tank shall also be accepted.	
	e)	Pipes	Seamless steel piping shall be used in the system.	
	f)	Seal oil pressure	The seal oil pressure shall be maintained at a pressure suitably in excess of the generator casing hydrogen pressure. The differential pressure shall be kept constant, once set at the time of commissioning, at all hydrogen pressures and all regimes of generator operation. The pressure regulator or the regulating valve used for the purpose shall be adjustable type.	
	g)	Oil level Monitoring	The seal oil system shall be so designed that it is possible to run the machine at barring speed in air medium at a slightly positive air pressure without any modification in the system.	
			To be provided in the different tanks. For indication and alarm along with level gauge	
			Necessary hydraulic sealing arrangement shall be provided in H2 side oil discharge line to prevent circulation of gas due to any possible difference of heads developed by fans mounted at the end of the generator rotor.	
	h)	Coolers	Two (2) number 100% duty seal oil coolers along with necessary 3 way valves (as applicable) for isolating or bringing one cooler in service, shall be provided. These coolers shall be shell and tubetype or Plate type suitable for using D.M. water of condensate quality.	
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	i) Cooler tube / Plate redundancy j) Water pressure k) Filters l) Temperature/Flow Measurement m) Pressure monitoring n) Control p) Alarms in TG MMI & Annunciation contacts for use in station DDCMIS shall be provided for these conditions	Seal oil coolers shall be designed to have 15% excess tube or plate surface area over and above designed tube or plate surface area required for the rated load conditions while maintaining the design pressure drop on cooling water side. The oil pressure in the cooler shall be greater than water pressure under all operating conditions. Suitable filters of 2x100% duty shall be provided. It shall be possible to carry out cleaning and maintenance of any cooler and filter when the machine is in operation. Temperature gauges and flow meters shall be provided at all appropriate locations. Pressure gauges and Transmitters shall be provided at least at the following locations i) At the inlet (as applicable) and outlet of pumps. ii) At the outlet of the cooler iii) At the inlet and outlet of the pressure regulators and filters or differential pressure across filters. iv) At the oil supply header (as applicable). The system shall be controlled as part of turbine control system at CCR. The local Generator auxiliary panel (located at 0.0m) shall be complete with all lamps, indicators, power supplies etc. Further following instruments shall be provided: i) indicators for seal oil-hydrogen differential pressure. ii) indicators for temp. of seal oil at the seals. i) Pressure of seal oil-Low. ii) Pressure of thrust oil-Low (if applicable) iii) Oil level in damper tank-Low (if applicable) iv) Oil level in damper tank-(if applicable Emergency) v) Oil level in hydraulic seal-High. (if applicable) vi) Oil level in hydraulic seal-Low (if applicable) vii) Automatic switching on of AC standby oil pump. viii) Automatic switching on of DC emergency oil pump. ix) Differential pressure between oil and hydrogen-High. x) Differential pressure between oil and hydrogen-Low. xi) AC seal oil motor power supply failure. xii) DC seal oil motor power supply failure. xiii) AC/DC seal oil motor control faulty. xiv) Seal oil temperature -high.		
9.00.00	STATOR WATER COOLING SYSTEM (AS APPLICABLE)			
9.01.00	General	Cooling shall be provided with a closed loop stator water cooling system. The system shall generally include but not be limited to the following.		
	a) Stator water cooling tank	One (1) of stator tank shall be provided. The Bidder shall indicate and provide devices to detect, trap, monitor and release the hydrogen, that leaks in to the stator water cooling		
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9.02.00	b) Make up water c) Water to water heat exchangers d) Filters e) Circulating water pumps f) Demineraliser g) Piping Instrumentation	system, to a safe place outside the building through suitable safety valves or vents. Make-up water for primary water system shall be tapped off from condensate extraction pump discharge header (before and after the condensate polisher) and from DM water make-up line to the condenser. However Contractor's standard and proven arrangement of tapping make up water for primary water shall be accepted. The level in the tank shall be maintained by means of suitable valves in the make up line. Two (2) 100% capacity shell and tube type or plate type. The water to water heat exchanger shall be designed to accept secondary D.M. water (condensate quality). The system shall be so designed that the pressure of primary DM water inside the cooler is always greater than that of secondary DM water (condensate quality) The exchanger shall be designed to have 10% excess tubes or plate surface area as applicable over and above the designed requirements for the rated load condition while maintaining the design pressure drop on cooling water side. Two (2) 100% capacity fine wire mesh filters with magnet bars of unlimited life for removal of all magnetic particles. The permanent magnet bars shall be protected by sleeves of stainless steel. It shall be possible to clean easily the ferromagnetic particles adhering to the magnet bars during capital maintenance. Alternatively, standard and proven practice of bidder regarding type of filter shall also be accepted. Two (2) 100% capacity A. C motor driven. Standby pump shall cut in automatically in case the working pump fails or the pressure of circulating water drops below a certain preset value. One (1) mixed bed demineraliser (MBD) of adequate capacity to maintain the required quality of water. The MBD shall remain continuously in service in order to retain high purity of stator cooling water with its associated electrical resistivity. The Bidder shall indicate in the proposal the capacity of MBD necessary to maintain the quality of water at the desired level for a time duration of six months or more. It shall be designed that the MBD could be taken out of service for refilling without untoward effect on the system which could necessitate load reduction/rejection. Set of stainless steel piping. The hangers and supports, valves and other fittings for the complete water system is also in the scope of Contractor. The following minimum instrumentation shall be provided i) Set of conductivity meters in the main water circuit and after the demineraliser. ii) Set of flow measurement (at least two nos.) to monitor low distillate condition and flow transmitters/meters for primary water to stator winding and main bushing (as applicable), make up water etc. iii) Pressure gauges at the inlet and differential pressure gauge across filter, pressure gauges at the inlet and differential pressure gauge across stator winding, differential pressure switches and pressure	
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9.06.00	On line dissolve oxygen monitoring System	To be provided for stator water system which operates in low oxygen regime at neutral pH. However, On line dissolve oxygen monitoring System is not mandatory for stator winding with SS hollow conductors.		
9.07.00	Stator coolant flow	To be monitored in TG MMI.		
9.08.00	Generator auxiliary system valves, piping, tanks and coolers etc. shall be designed for at least 10 Kg/sq.cm gauge pressure irrespective of a lower operating pressure. The maximum continuous rating of the pump and motor at specified ambient temperature shall be at least the maximum load demand of the driven equipment in its entire range of operation including run out flow condition when operating at frequency variations from 47.5 Hz to 51.5 Hz.			
9.09.00	The turbine generator control VDU in the central control room should have graphical display of various generator subsystems, process/flow diagrams such as stator cooling water, seal oil, hydrogen, lube oil, generator stator and rotor parameters along with display of generator capability curves and operating point, generator stator & rotor temperatures and vibration parameter etc. These should have limit values alarm/trips tag numbers etc. clearly displayed on VDUs. In addition operator help features for control of these systems and historical and reference data shall also be made available for efficient operator guidance of these systems.			
10.00.00	GENERATOR EXCITATION SYSTEM			
10.01.00	A complete generator excitation and voltage regulating system shall be provided with the generator. The system shall be either a completely static excitation system or a brushless excitation system to meet the requirement specified herein. The Generator excitation system shall be standalone system. All panels of excitation system shall be in single suite. It shall have provision of connection to TG MMI through network interface. However it shall also be able to operate the Generator excitation system without this interface.			
10.02.00	Characteristics	The excitation system shall have matching characteristics suitable for satisfactory parallel operation with other generators in the plant.		
10.03.00	Fail safe requirement	The various change over relays and other equipment associated with supply system other than AVR control supply, electronic circuits of either channel etc., shall be such that the loss of their control supply does not lead to the excitation system outage.		
10.04.00	Interface	The necessary inputs and interface equipment shall be provided with Generator Excitation and Automatic Voltage Regulator for hooking up with Turbine Automatic Run up system, Electro Hydraulic Governing System and DCS for operation and control. The minimum indicative list of signals required for interfacing with DCS is enclosed at Annexure-I. Signal interface (Hardwired/Soft) shall be finalized during detailed engineering.		
10.05.00	Equipment design & sizing criteria			
10.05.01	General	When the generator is subjected to a sudden loss of rated output at rated power factor, the system shall be capable of restoring the voltage of within 2% of the nominal preset value within negligible time, so as not to initiate the protection equipment.		
10.05.02	Redundancy	The excitation system shall have two (2x100%) AVR channels including complete independent power supplies and controls. Each channel shall be equipped for 'Auto Operation' with the facility for selecting either channel in 'Auto' or 'Manual' mode.		
10.05.03	Margin	Each excitation system channel shall be designed to continuously carry currents of at least 10% above the field		
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10.05.04	Excitation system response time as per IEEE 421 A		current requirement at generator MCR condition and higher currents for short time duty. Short time duty as mentioned above shall be on MCR base as per clause 1.14 of part III in VDE 530.	
10.05.05	Excitation response ratio	< 0.5 sec		
10.05.06	Excitation system ceiling voltage	> 2		
10.05.07	Field forcing capability	> 1.5 times rated load excitation voltage.		
10.06.00	Voltage regulator	Each excitation system channel shall be capable of supplying without damage to any of the components, the field forcing voltage and current of the system for a period of 10 seconds without exceeding the limits of temperature for rectifier junction and heat sink, when the equipment starts at normal operating temperature.		
10.06.01	Number of channel	The excitation system shall be designed in such a manner that due to any fault in AVR firing circuit pulse transformer, rectifying elements in any channel etc. excitation system shall be available with its full capacity. All rectifying elements shall have over voltage and short circuit protection.		
10.06.02	Type	Two numbers fully equipped automatic channels. Either channel shall be capable of being the main or standby. Either channel shall be capable of being selected as manual also.		
10.06.03	Input to AVR	Automatic voltage regulators shall be either of solid state type or microprocessor/PLC based as per manufacturer's standard and having negligible dead band suitable for a large interconnected system.		
10.06.04	Characteristics	Current transformer secondary 5A potential transformer secondary 110V phase to phase.		
	a) Auto control range	+/- 10% of rated terminal voltage in all modes for voltage level adjustments of generator operation.		
	b) Frequency range of operation	47.5 to 51.5 Hz		
	c) Accuracy at which	Better than 0.5% of the set value over the whole Generator voltage to be heldload range of the machine.		
	d) Range of transformer drop compensation	0 to 15%		
	e) Max. change in generator voltage when AVR is transferred from auto to manual under all conditions of excitation.	Less than 0.5%		
10.06.05	f) Manual control range	70% of no load to 110% full load excitation.		
	Technical features	Voltage regulator shall have the following provisions.		
	a) Maximum and minimum excitation limiter.			
	b) Channel reference control	Either solid state or microprocessor control.		
	c) Ramp generation circuit	To enable gradual rise of reference signal applied to the circuit to avoid sudden voltage build up.		
	d) Transformer drop	Suitable feedback proportional to transformer		
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10.06.06	e)	compensation Power system stabiliser (PSS)	drop to be provided for compensation PSS shall be suitable for damping the various modes of electro-mechanical oscillations at all frequencies in the range of 0.2 to 3 Hz under varying generator loading and power system network configurations. PSS shall be adaptive to varying operating conditions with features to compute optimum stabilising signal along with suitable scheme for identifying external reactance of the generator. Facility for remote manual switch off-on along with indication shall be incorporated.		
	f)	Rotor angle limiter	A rotor angle limiter shall be incorporated in the system. This shall enable to keep the angle between the direct axis of the machine and network vector within the set reference value as determined by stability, by adjusting the excitation. Alternatively bidder's standard and proven AVR scheme to ensure machine operation within capability curve limit shall be accepted.		
	g)	Stator current limiter	The stator current limiter shall act immediately in under-excited range. The time delay in over-excited range shall enable a temporary overloading of the machine.		
	h)	Rotor Current limiter	The regulator shall act with time delay, so that the regulation dynamics are not impaired in case of a fault.		
	i)	Voltage/frequency(V/Hz) limiter	To limit the ratio of generator voltage and frequency at all operating conditions to such a value that the maximum generator transformer core flux density does not exceed the value specified.		
	j)	Follow up	In order to avoid a sudden change in generator voltage when voltage regulation is transferred from 'Main' to 'Standby', or 'Auto' to 'Manual', a suitable arrangement shall be provided to follow up changes in 'Auto' mode along with follow up indication in Unit Control Room (UCR). An alarm and visual indication shall be provided to indicate change over from Auto channel-1 to Auto channel-2 or 'Auto' to 'Manual'.		
	k)	Automatic changeover from Auto-1 to Auto-2 or vice versa	Shall be possible in case of trouble in the running channel.		
	l)	Automatic changeover from Auto to manual	Automatic change over shall be possible from 'Auto' to 'Manual' in case of : Generator protection circuit operation i.e. after field forcing and over excitation condition with a time delay. Loss of terminal voltage feedback by way of any of the VT fuse blowing up Faulty over excitation condition.		
				- Loss of automatic channel reference signal - Power supply failure in the automatic channel - Manual intervention - Any other condition as considered necessary by the Contractor	
	All the above conditions and the conditions of limiter operations shall be annunciated in local panel as well as in TG MMI. Local regulator panel shall be complete with necessary facia window sequence logic, power supplies, accept reset test push buttons, indicating lamps, control switches, local/remote switches, auxiliary relays and programmable logic controllers, etc.				
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10.06.07	In addition, one (1) Configuration Tool shall also be supplied per unit to facilitate programming of DAVR and downloading of records locally. Suitable communication port, cables, interfacing software etc shall be provided. The configuration of the Tool shall be finalized during detailed engineering. The required software for logic testing/ parameter setting/ programming/ steady state testing/ dynamic testing of all the DAVR functions including Limiters, PSS etc. shall be supplied. The requisite license/ dongles shall be provided. It shall be possible to carryout DAVR functional tests from the Configuration Tool by interfacing from the front ports during initial commissioning and later. These features shall be demonstrated during Workshop Training at Site. Configuration Tool to be provided by the Contractor should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Employer's approval. The software packages including OS/ anti-virus etc. shall be included with the Configuration Tool and shall be the latest version available at the time of supply. The screen size of the configuration tool should be 15 inches or more.			
10.06.08	Workshop Training shall be conducted at site for familiarization of site Engineers for commissioning and day to day O&M of Generator excitation system. The scope shall include training for a batch of 10 Engineers at Project site. One such workshop training shall be conducted before and after one Unit commissioning. Employer shall provide the required infrastructure such as Training conference room, Projection systems etc.			
11.00.00	FEATURES OF STATIC EXCITATION SYSTEM (If applicable)			
11.01.00	General Description	The excitation system shall broadly consist of: a) Rectifier transformer b) Regulator cubicle c) Thyristor convertor cubicles along with firing controls. d) DC excitation cubicle housing: - A field circuit breaker. - A main field flashing device. - An over voltage protection. e) Interconnecting cables between different equipment/panels of the system. f) Connection from Excitation Transformer to Thyristor cubicle shall be by ac busduct. g) Connection from Thyristor cubicle to Generator Slip Rings shall be by dc busduct.		
11.02.00	Rectifier Transformer	a) Type Indoor, electrolytic grade Copper winding, epoxy moulded dry type, 3 phase step down transformer with Thermal Class 155 (F) insulation complete with flanges and terminal lugs for connection to the generator terminals through isolated phase bus ducts. The transformer shall conform to IEC-60076-11. Transformer shall be provided with fans/blowersfor forced air cooling however all tests and performance shall correspond to air natural cooling. Fans/Blowers (AF cooling) shall have Manual and Auto control. b) Temperature rise 70 deg.C over an ambient temperature of 50 deg.C without fan/blower and 65 deg C. over an ambient temperature of 50 deg.C with fan/blower c) Fault rating Withstand through fault current for the time duration equal to de-excitation time of the generator field current for such faults under AVR/manual operation. d) Housing Sheet steel cubicle		
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11.03.00	e) Protection	A set of CTs (12 nos) shall be provided in the primary and secondary of rectifier transformer for overload, metering and transformer differential protection. These CT parameters shall be finalized during detail engineering as per protection scheme. Hot spot temperature measurement in each limb of the transformer alongwith indication as well as alarm and trip contacts shall be provided.		
	Power Thyristor Convertor			
	a) Type	Fully controlled three phase, full wave bridge type facilitating fast and high ceiling performance. Suitable to ensure trouble free service of the cells under all fault conditions. The convertor shall have 'N+2' redundancy where N is the number of bridges required to deliver rated excitation current and 'N+1' number of bridges shall be able to deliver the ceiling voltage/current as mentioned elsewhere in the specifications.		
11.04.00	b) Protection	The thyristors shall be selectively protected against overloads by ultra high speed fuses. Suitable lamps indication or alarms shall also be provided to indicate the defective 'thyristor'.		
	c) Load Sharing	All the thyristor bridges shall be designed to share equal load current. Individual bridge current shall not vary by more than 10% of the average current of all bridges. Indication shall be provided for each bridge current (DC side). However Contractor's standard and proven arrangement shall be accepted.		
	Gate Firing Circuit	The firing circuit shall have the following essential features : a) It shall produce a gate pulse for every thyristor once in a cycle. b) It shall provide a linear relationship between the regulating inputs volts and rectifier output. c) The firing circuit shall have negligible time lag. d) It shall fire the thyristors correctly for any situation of input voltage, depression or unbalance coupled with high or low field currents		
11.05.00	Pulse Transformer	There shall be a pulse transformer between the individual gates of the parallel connected thyristors and between the main current circuit and the control circuit.		
11.06.00	Field Flashing	The initial field flashing shall be from the station's 415 V auxiliary AC supply. Suitable rectifier filters, etc. required for converting this ac supply to the required DC supply shall be housed in the excitation system cubicle. Suitable protection interlock with desired time delay shall be provided so that when the AC terminal voltage of the generator is built up to the required level for the main excitation rectifier system to take over, the field flashing circuit is switched off. In case the main excitation system fails to take over after a predetermined time of field flashing, the field breaker should trip automatically. An annunciation for field flashing failure/main field breaker trip due to field flashing failure shall be incorporated. All the components of field flashing system shall be continuously rated irrespective of its short time duty requirement so as to guard against any failure in case of its prolonged mal-operation.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.07.00	Field Application & Suppression Arrangement: a) Field breaker The generator field breaker shall be of AC or DC (multipole or single pole) air break type, suitable for operation from local panel as well as from Unit Control Room (UCR). The breaker shall have arc quenching arrangement for both the main poles as well as the discharge contacts. Breaker shall be designed to carry currents for continuous as well as short time duty of the excitation system. Breaking current capacity of the breaker shall match with the fault level at the output DC bus. Discharge contacts shall be rated to discharge the field energy corresponding to the highest field current which may come during its entire operating range. The breaker shall be complete with control switches, indication lamps, local/remote selector switch, etc. However Contractor's standard and proven system for field discharge shall be accepted. b) Discharge resister Non-inductive for quick discharge of inductive energy and thereby controlling the voltage across the field. However Contractor's standard and proven arrangement for quick discharge of inductive energy and voltage control across field winding shall be accepted. c) Option Separate breakers for field application and suppression may also be considered if it is Contractor's standard arrangement. d) Interlocks Suitable interlock shall be provided to prevent closing of the field breaker unless the regulator reference signal is at/near the minimum setting and minimum machine speed of 95% is attained. Adequate number of normally open and normally closed field circuit breaker auxiliary contact for remote position indication and interlocking with generator and field flashing circuit shall be provided. e) Collector rings, Brush gears and Brushes i) Enclosure For static excitation system, a suitable brush gear with brush assembly, in a well ventilated enclosure shall be provided. However for brushless excitation system the same is not applicable. ii) Collector rings Insulated helically grooved, alloy steel collector rings shrunk on the rotor. For cooling the slip rings, if required, suitable fans shall be provided either on the collector rings or on the rotor shaft adjacent to it. iii) Brush position Located only on the upper two third periphery of collector rings. The brushes shall be staggered along the length of collector ring to avoid any non-uniform ring wear. iv) Access doors and inspection windows To be provided to enable replacement and inspection of brushes while the machine is in operation v) Brush holders Constant pressure type which can be adjusted as per requirement. Suitable insulation shall be provided to prevent passage of current through pressure device.			
12.00.00	FEATURES OF BRUSHLESS EXCITATION SYSTEM (IF APPLICABLE)			
12.01.00	General Description The complete equipment shall be mounted on a bed plate and enclosed by suitable exciter cover. The system shall broadly consist of: a) Permanent Magnet Generator (PMG) type pilot exciter.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS 			
12.02.00	Pilot Excitation System	b) Rectifier unit for PMG c) Brushless main exciter d) Rotating rectifier unit e) Regulator cubicle f) Complete instrumentation and protection system. g) Inter-connecting cables between different components of the system a) The pilot exciter shall be revolving field, salient pole, permanent magnet high frequency type. The armature shall be stationary 3 phases feeding current to the static rectifier assembly and excitation control equipment. The rotor shall be magnetised and stabilised by the Manufacturer to give stable magnetisation characteristic during operation. b) The stator winding shall be of Thermal Class 155 (F) insulation or better, suitable for operation at 50 deg.C ambient temperature. The machine shall be fitted with fans for self ventilation.		
12.03.00	Convertor Assembly	Converter assembly of pilot excitation system, thyristor gate firing system & pulse transformer shall have 2x100% redundancy. All the thyristor bridges shall be designed to share equal load current. Individual bridge current shall not vary by more than 10% of the average current of all bridges. Indication shall be provided for each bridge current (DC side).		
12.04.00	Brushless main exciter	a) Armature This shall be of rotating armature, 3-phases, star connected, feeding current to the rotating diodes mounted on the exciter shaft. b) Armature core The armature core shall be made from silicon sheet lamination to reduce eddy losses and shall be suitably varnished on both sides. c) Exciter enclosure and support The exciter shall be totally enclosed, self ventilated, frame supported on the generator foundation having journal bearings. d) Heat exchanger Integrally mounted air to water heat exchangers. The heat exchangers shall be designed for DM water (Condensate quality). Sizing criteria for the heat exchanger shall be similar as for generator mounted hydrogen cooler. e) Insulation The stator and rotor winding insulation shall be of Thermal Class 155 (F) with the temperature rise limited to class B limits of IEC 60034. - f) The armature conductor in the overhang portion shall be adequately held to withstand the electro-dynamic forces during field forcing condition. Rotor winding retaining ring shall be made up of stress corrosion resistant material.		
12.05.00	Rotating Rectifier Assembly	a) The rectifier assembly made of silicon diodes shall be arranged as two distinct rings with opposite polarity diodes on respective rings. b) The diodes shall be connected in a conventional three arm full wave rectifier bridge. Rectifier assembly shall have one complete bridge as redundant.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
12.06.00 12.07.00	Exciter Field Application Instrumentation and Protection	Alternatively a single three phase rectifier bridge having atleast one redundant parallel branch in each of the six arms of the bridge may also be considered. Rectifier assembly shall have same requirements as regards the component features and rating as detailed out for the thyristor assembly. c) Diodes shall be cooled by forced air circulation by means of fans mounted on the main exciter. d) Each diode shall be provided with a fuse together with visual indication in the event of diode failure. e) The output from the rectifier shall be fed to the generator field through the bore of the rotor shaft and necessary plug in type of shaft connection. The axial copper connector shall be designed such that it shall be possible to disconnect this connector at the point where the exciter shaft couples to the generator so that, if necessary, the generator and exciter can be tested individually. As detailed out in Static excitation system. However, bidder's standard and proven method of Field Suppression is also acceptable. a) The system shall generally include, but not be limited to, the following: i) Suitable twin resistance temperature detectors for measuring hot and cold air temperature of exciter with necessary provisions for protection tripping/interlocks. ii) Dial type thermometer for measuring the inlet and outlet temperature of water to the air coolers. iii) Pressure gauges at the inlet and outlet of water to air coolers. iv) Instruments and devices for the measurement of rotor winding temperature. v) Stroboscope or suitable alternative device for detection of faulty rotating diode element. vi) Suitable arrangement for exciter field suppression. b) A pair of auxiliary slip rings shall be provided to give access to the rotor circuit allowing an earth fault detector circuit to be connected. c) For all alarms in the system, pressure and temperature measurement etc provided at suitable points shall be used. d) For unit interlock and protection system two out of three protection system shall be adopted. To comply with this Contractor shall furnish two or three separate sets of sensors etc. for parameters associated with unit interlock and protection shall be provided.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
13.00.00	STABILITY STUDIES The Contractor shall be required to carry out the detailed computer studies considering single machine with infinite bus so as to confirm the suitability of the Turbine generator and its excitation system in the grid for maintaining the power system stability under dynamic and transient conditions and tune the PSS parameters at site for all the machines. The data and worst possible conditions pertaining to Employer's system shall be discussed and finalised between Employer and the Contractor, in accordance with the system modeling techniques and depth of modeling. The Contractor shall furnish the details of simulation technique and method which he proposes to use for this purpose.			
14.00.00	TYPE TESTS			
14.02.00	LIST OF TYPE TESTS TO BE CONDUCTED			
14.02.01	The following type tests shall be conducted under this contract on one generator and Excitation system of each type and rating a) Instantaneous short circuit test to determine transient and sub-transient reactance parameters and to ensure stability of winding during sudden short circuit condition. The test shall be done in line with IEC 60034-3. At least one Instantaneous short circuit current test shall be performed at minimum 50 % of rated terminal voltage conditions. Note: If CT's are envisaged to be mounted on Generator Bushings then these CT's shall be mounted on Generator bushing during type test. Above CT's shall be routine tested again after type test at the same facility where CTs were pre-tested. b) Determination of negative sequence and zero sequence reactance and resistance. c) Determination of voltage waveform factor and Total Harmonic Distortion factor. d) Short circuit heat run test at two third of rated stator current at rated pressure and cooling parameters with one cooler/cooler section out of service and ten (10) percent of tubes plugged in remaining coolers/cooler sections that are in service. In case of unsymmetrical cooler configuration, test with all possible variants of one cooler out of circuit shall be carried out. e) Vibration measurement on all planes on stator overhang winding at suitable locations on each end and at other critical locations to be decided by Employer for the following conditions: i) Open circuit operation. ii) Short circuit operation. iii) Sudden short circuit conditions. iv) Stand still condition - with Hammer test. Minimum six (6) readings shall be taken for each end of the Generator. The test results of above shall prove that the values are within the normal operating limits for long satisfactory performance and that there are no components or parts which have natural frequency of resonance near operating frequencies or 100Hz. The above type tests shall be carried out keeping all conditions/ parameters as close as possible to site conditions with all the built-in instrumentation (like RTD etc.) suitably wired and the readings recorded. During various tests, bearing & shaft overhang vibrations shall also be measured with and without excitation. Recording of various parameters of bearing, seal oil system, gas system, stator water cooling system and environmental conditions (like temperature etc.) shall also be done.			
14.02.02	Brushless excitation system (if applicable) Following type tests shall be conducted			
	(a) Exciter Temperature rise test at peak rating of excitation system. Ceiling duty condition shall also be demonstrated (subject to test bed constraint). (b) Permanent Magnet Generator Temperature rise test at peak rating of excitation system. Ceiling duty condition shall also be demonstrated (subject to test bed constraint). (c) Converter Assembly (of the exciter field)			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.02.03	Temperature rise test at peak rating of excitation system. Ceiling duty condition shall also be demonstrated. (d) Input and output surge withstand capability test: The Fast transient SWC tests shall be conducted as per ANSI / IEEE C37.90.1-2002 / IEC 60255-22-04-2008. Static excitation system (if applicable) Following type tests shall be conducted a) Excitation transformer as per IEC-60076-11. i. Short circuit Test ii. Lighting Impulse Test iii. Temperature rise Test (with and without fan/blower) iv. Noise level Test b) Type tests on field breaker as per IEEE/ANSI C-37-18or IEC 60947-2 c) Temperature rise test of converter panel at MCR rating. Ceiling duty condition of excitation system shall also be demonstrated. d) Busducts shall be tested for material. One section shall be tested for following tests as per IS:8084 / ANSI IEEE-37.23 / IEC 60439-2,60529 & 62271. i. Temperature rise test ii. Dynamic and short time current test, iii. Degree of protection test and iv. one minute power frequency high voltage withstand test e) Test for estimating the discharging capability of the field discharge resistors in succession for at least two discharges. Alternatively, tests on field discharge resistors as per sub-supplier standards and applicable standards shall be subject to Employer's approval. f) Input and output surge withstand capability test: The Fast transient SWC tests shall be conducted as per ANSI / IEEE C37.90.1-2002 / IEC 60255-22-04-2008.			
14.03.00	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED			
14.03.01	Brushless excitation system (if applicable) (a) Excitation panels i) Soak test for panels. ii) Dry heat test as per IEC-60068-2-2 or equivalent for electronic modules iii) Damp heat test as per IEC-60068-2-30 or equivalent for electronic modules (b) Degree of protection test for Excitation system panels.			
14.03.02	Static Excitation system (if applicable) (a) Excitation panels i) Soak test for Electronic module. ii) Dry heat test as per IEC-60068-2-2 or equivalent for electronic modules iii) Damp heat test as per IEC-60068-2-30 or equivalent for electronic modules (b) Degree of protection test for Excitation system panels.			
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CLAUSE NO.

TECHNICAL REQUIREMENTS

15.00.00

(c) Tests on thyristors as per IEC 60747.

TRAINING

Contractor shall provide training on Generator, Excitation system including AVR, Generator end winding vibration monitoring system and Rotor flux monitoring system for Employer's personnel. The duration of the training shall be as elaborated in Part-C, Section-VI of technical specifications.

Annexure-I

S No	SIGNAL	SOURCE	DESTINATION	REMARKS
1	Field Current	AVR	DCS	
2	Field Voltage	AVR	DCS	
3	Channel centre ZERO balance	AVR	DCS	
4	Rotor winding temperature	AVR	DCS	
5	AUTO/MANUAL status	AVR	DCS	
6	AVR Ch-I selection status	AVR	DCS	
7	AVR Ch-II selection status	AVR	DCS	
8	AVR status(ON/OFF)	AVR	DCS	
9	AVR ceiling status	AVR	DCS	
10	Turbine Speed > 95% permissive available	DCS	AVR	
11	CLOSING PERMISSIVE FOR HV CB- AUTO SYNCH -1	AVR	DCS	
12	CLOSING PERMISSIVE FOR HV CB- AUTO SYNCH -2	AVR	DCS	
13	FCB status (ON/OFF)-1	AVR	DCS	
14	FCB status (ON/OFF)-2	AVR	DCS	
15	FCB status (ON/OFF)-3	AVR	DCS	
16	FCB status (ON/OFF)-4	AVR	DCS	
17	Field flashing failure alarm	AVR	DCS	
18	PSS ON status	AVR	DCS	
19	AVR channel failure (channel change)	AVR	DCS	



20	AVR trouble alarm	AVR	DCS	
21	AVR Limiters Operated	AVR	DCS	
22	AVR Trip to GRP TRIP (86G1)	AVR	GRP	
23	AVR Trip to GRP TRIP (86G2)	AVR	GRP	
24	AVR Ch-I selection command	DCS	AVR	
25	AVR Ch-II selection command	DCS	AVR	
26	AVR Voltage Lower	DCS	AVR	
27	AVR Voltage Raise	DCS	AVR	
28	Permissive for Autosynch-1	DCS	AVR	
29	Permissive for Autosynch-2	DCS	AVR	
30	HVCB status (any one) (ON)	GRP	AVR	
31	HVCB status (both) (OFF)	GRP	AVR	
32	GRP RESET (86G1)	GRP	AVR	
33	GRP RESET (86G2)	GRP	AVR	
34	GRP TRIP (86G1) TO AVR TRIP	GRP	AVR	
35	GRP TRIP (86G2) TO AVR TRIP	GRP	AVR	
36	VT fuse failure channel-1	GRP	AVR	
37	VT fuse failure channel-2	GRP	AVR	
38	Generator Earth Switch OPEN	GRP	AVR	
39	Field Voltage Low	AVR	GRP	(Static excitation system only)

NOTE 1: The above signals shall be provided for implementation of interface of AVR with DCS/GRP. Bidders shall use separate signals for DCS/ATRS/EHC/Auto Synchroniser as required. All interface signals with Switchyard/GRP and trip signals shall be exchanged through hardwire only.

NOTE 2: GRP means 's Generator Relay Panel



SUB-SECTION-B – 02

MOTORS

CLAUSE NO.	TECHNICAL REQUIREMENTS				
	80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.				
6.00.00	OPERATIONAL REQUIREMENTS				
6.01.00	Starting Time				
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.				
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.				
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.				
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.				
6.02.00	Torque Requirements				
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor rated torque.				
6.02.02	Pull out torque at rated voltage shall not be less than 205% of rated torque. It shall be 275% for crane duty motors.				
6.03.00	NOT USED				
7.00.00	DESIGN AND CONSTRUCTIONAL FEATURES				
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.				
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACW) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below				
7.03.00	(a)	Fuel oil area	:	Group – IIB	
	(b)	Hydrogen generation	:	Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)	
	Winding and Insulation				
	(a)	Type	:	Electrolytic grade Copper conductor, Non-hygroscopic, oil resistant, flame resistant Insulation.	
	(b)	Starting duty	:	Two hot starts in succession, with motor initially at normal running temperature. However , conveyor motors shall be suitable for 3 consecutive hot starts	
7.04.00	(c)	11kV, KV & 3.3 kV AC motors	:	Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.	
	(d)	240VAC, 415V AC & 220V DC motors	:	Thermal Class (F) or better	
	Motors rated above 1000KW shall have insulated bearings/housing to prevent flow of shaft currents.				
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.		
7.06.00	Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.		
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with 3 numbers duplex RTDs connected to three numbers dual input transmitters with display. However for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers dual input transmitters with display unit.		
7.08.00	Motor body shall have two earthing points on diagonally opposite sides.		
7.09.00	11 KV motors shall be offered with Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover and trifurcating sleeves. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.		
7.10.00	3.3/6.6 KV motors shall be offered with dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box. Contractor shall provide termination kit for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.		
7.11.00	The spacing between gland plate & centre of bottom terminal stud shall be as per Table-I.		
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.		
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 6.6 KV, 3.3 kV /415V systems without any injurious effect on its life.		
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.		
7.15.00	NOT USED.		
8.00.00	NOT USED.		
10.00.00	TYPE TEST		
10.01.00	HT MOTORS		
	LIST OF TYPE TESTS TO BE CONDUCTED		
	The following type tests shall be conducted on each type and rating of HT motor		
	(a) No load saturation and loss curves upto approximately 115% of rated voltage		
	(b) Measurement of noise at no load.		
	(c) Momentary excess torque test (subject to test bed constraint).		
	(d) Full load test(subject to test bed constraint)		
	(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.		
	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED		
	The following type test reports shall be submitted for each type and rating of HT motor		
	(a) Degree of protection test for the enclosure followed by IR, HV and no load run test.		
	(b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
10.02.00	(c)	Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15		
	(d)	Surge-withstand test on inter-turn insulation shall be as per clause no. 4.2 of IEC 60034, part-15		
	LT Motors			
	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED			
	The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only			
	1.	Measurement of resistance of windings of stator and wound rotor.		
	2.	No load test at rated voltage to determine input current power and speed		
	3.	Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)		
	4.	Full load test to determine efficiency power factor and slip		
	5.	Temperature rise test		
10.03.00	6.	Momentary excess torque test.		
	7.	High voltage test		
	8.	Test for vibration severity of motor.		
	9.	Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)		
	10.	Test for degree of protection and		
	11.	Overspeed test.		
	12.	Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1		
	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.			
	10.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.		
	TABLE - I			
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS				
Motor MCR in KW		Minimum distance between centre of bottom terminal stud and gland plate in mm		
UP to 3 KW		As per manufacturer's practice.		
Above 3 KW - upto 7 KW		85		
Above 7 KW - upto 13 KW		115		
Above 13 KW - upto 24 KW		167		
Above 24 KW - upto 37 KW		196		
Above 37 KW - upto 55 KW		249		
Above 55 KW - upto 90 KW		277		
Above 90 KW - upto 125 KW		331		
Above 125 KW-upto 200 KW		385/203 (For Single core cables only)		
For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.				
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CLAUSE NO.	TECHNICAL REQUIREMENTS											
	PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE: NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows: <table><tr><th>Motor MCR in KW</th><th>Clearance</th></tr><tr><td>UP to 110 KW</td><td>10mm</td></tr><tr><td>Above 110 KW and upto 150 KW</td><td>12.5mm</td></tr><tr><td>Above 150 KW</td><td>19mm</td></tr></table>				Motor MCR in KW	Clearance	UP to 110 KW	10mm	Above 110 KW and upto 150 KW	12.5mm	Above 150 KW	19mm
Motor MCR in KW	Clearance											
UP to 110 KW	10mm											
Above 110 KW and upto 150 KW	12.5mm											
Above 150 KW	19mm											
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SUB-SECTION-B – 03

VFD

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00 <				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV IS/IEC: 62271-200 AC electricity metersIS: 722 Metal oxide surge arrester without gap for AC systemIEC: 60099-4 Terminal blocks for copper conductorsIEC: 60947-7-1 Dry transformerIS: 11171 MotorIS:15999, IEC-60034, IEC60034 / NEMA 30 & 31 Contactors/Switches/Fuses etc.IEC:60947, IS: 13947 Harmonics & EM compatibilityIEEE:519/IEC: 61000 VFDIEC: 60034/ IEC: 61800			
3.00.00	OPERATING CONDITIONS			
3.01.00	For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.			
3.02.00	All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.			
3.03.00	The voltage level for the VFD output to be fed to motor shall be as follows:- 1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC 2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC 3. Above 700KW : Medium Voltage From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.			
4.00.00	SYSTEM DESCRIPTION			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.00.00 GENERAL REQUIREMENTS	Type of drive	3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT		
	Type of Cooling of VFD	Naturally air cooled/forced air cooled/Liquid cooled		
	Converter Type	Full wave diode rectifier/active front end type		
	Inverter Type	Thyristor/IGBT/IGCT/SGCT/IEGT		
5.01.00	Medium Voltage VFD: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.			
5.02.00	415 V/690 V LV VFD: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design/6 pulse with active frontend harmonic filter. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.			
5.04.00	The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.			
5.05.00	The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.			
6.00.00	TECHNICAL AND OPERATIONAL REQUIREMENTS			
6.01.00	The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.			
6.02.00	The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.			
6.03.00	The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load: a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range. d. Any other as specified in data-sheet			
6.04.00	VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.			
6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.		
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.		
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.		
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.		
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.		
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.		
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.		
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.		
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.		
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.		
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.		
7.00.00	VFD COMPATIBILITY WITH THE MOTOR		
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.		
7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.		
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.		
8.00.00	BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)		
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.			
9.00.00	STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)			
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.			
	Note : Clause no: 8.00.00 and 9.00.00 is applicable as per the system requirements mentioned in the respective mechanical chapters.			
10.00.00	EFFICIENCY			
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency(Includes the transformer if applicable) shall be minimum 96.5% for LV VFD and minimum 95 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.			
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.			
11.00.00	COOLING SYSTEM			
11.01.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).			
11.2.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.			
11.03.00	Air cooled VFDs shall be provided with redundant cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.			
12.00.00	TRANSFORMER:			
12.01.00	Type: Outdoor Mineral oil filled ONAN type or Indoor air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.			
12.02.00	All other components, technical parameters shall be as per applicable IEC/IS.			
12.03.00	Enclosure for Dry Type Transformer (as applicable)			
	Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.			
12.04.00	Core	Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.		
12.05.00	Winding conductor	Shall be electrolytic grade copper.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Windings shall be of class F insulation or better.			
12.06.00	Winding temperature Indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb.		
12.07.00	Thermistors	Shall be embedded in each limb with alarm and trip contacts for remote annunciation.		
12.08.00	Temperature rise: For dry type transformer the winding temperature rise shall be class-F (90 deg) for Class-H insulation and class-B (70 deg rise) for Class-F Insulation winding over an ambient of 50 deg.			
13.00.00	POWER CONVERTER:			
13.01.00	The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.			
13.02.00	The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.			
13.03.00	Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.			
13.04.00	All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.			
13.05.00	The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.			
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.			
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.			
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.			
14.00.00	OUTPUT FILTER (AS APPLICABLE):			
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.			
15.00.00	DC LINK CAPACITOR (AS APPLICABLE):			
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.			
16.00.00	AC/DC Reactor (As applicable) 1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.			
17.00.00	VFD PANEL REQUIREMENTS			
17.01.00	Enclosure frames and load bearing members shall be as per the Chapter B-05 and B-06.			
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.			
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947			
17.04.00	Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.			
17.05.00	Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.			
17.06.00	Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.			
18.00.00	NOT USED.			
19.00.00	HT SWITCHGEAR			
19.01.00	The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.			
20.00.00	MOTORS			
20.01.00	VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side for motor frame size above 250 frame. However, contractor's proven practice with respect to use of insulated bearing in VFD driven motor may be accepted subject to Employer's approval.			
20.02.00	Motors shall also meet the requirements mentioned in subsection for motors, relevant portions of the specifications for driven equipment and relevant IS/IEC.			
20.03.00	Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.			
20.04.00	Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	limits as per IEC-61800.		
20.05.00	Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.		
20.06.00	Other requirements of motor shall be as stipulated in technical chapter of Motors and driven equipment in Part-B of technical specifications.		
21.00.00	LT & HT CABLES		
21.01.00	Contractor’s scope shall also include LT and HT cables suitable for VFD system andMotors.		
22.00.00	CONTROL AND PERFORMANCE REQUIREMENTS		
22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a “soft start” torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.		
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.		
22.03.00	Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS. Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room. Parameter Monitoring: - Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque - Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature - Run/stop and local/remote status displayed		
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.		
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.		
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.		
23.00.00	PROTECTION FEATURES		
23.01.00	The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following: i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection. v) Instantaneous Over current & Earth fault protection vi) Converter/Inverter module failure indication. vii) Over frequency/speed protection. viii) Ventilation failure indication & alarm. ix) Over temperature of VFD x) Bearing temperature protection. xi) System earth fault protection. xii) Speed reference loss protection.			
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.			
24.00.00	CONTROL FEATURES			
24.01.00	Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door. i) Start / stop (in local/remote mode) ii) Speed control (Raise / lower) iii) Acknowledge/Accept/ Test Push Button for annunciation iv) Auto / Manual / Test Mode select v) Emergency stop vi) Trip-Remote Breaker			
25.00.00	DIAGNOSTIC FEATURES			
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.			
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.			
26.00.00	SERVICEABILITY / MAINTAINABILITY			
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
26.02.00	Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.			
27.00.00	NOT USED.			
28.00.00	TESTS			
28.01.00	ROUTINE TESTS			
	All acceptance and routine tests as envisaged in QA section shall be carried out. Charges for these shall be deemed to be included in the equipment price.			
28.02.00	TYPE TESTS			
	LIST OF TYPE TESTS TO BE CONDUCTED			
	The following type tests shall be conducted under this contract for MV VFD			
	i) Overall efficiency determination of VFD system including transformer/ Harmonic filters etc at motor full load			
	ii) Temperature rise test			
	iii) Noise level			
	iv) Harmonics of No load current.(Input/Output)			
	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED			
	The following type test reports shall be submitted for VFD Panels'			
	1) VFD panels (For LV VFD used with load >= 50 KW)			
	i. Rated Current/ Output			
	ii. Temperature rise test			
	iii. Noise level test			
	iv. Power Loss Determination Test			
	v. Power factor measurement.			
	vi. Degree of Protection Test			
	vii. EMC Test			
	viii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800			
	2) VFD panels (For MV VFD)			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
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SUB-SECTION-B – 04

TRANSFORMERS AND ASSOCIATED EQUIPMENTS

This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A.

1.00.00 POWER TRANSFORMERS&SHUNT REACTOR

1.01.00 TYPE& RATINGS (for continuous duty)

Sr. No.	TRANSFORMER	Generat or Transfo rmer (GT)	Station Transform er (ST)	Unit Transf ormer (UT)	Auxiliary Transformer (including LT Outdoor)	Shunt Reactor
i)	Rating	As per system requirement/SLD/Sub section B-0				
ii)	Voltage Ratio(KV)	Generati on Volt/ 420/√3	ST: 400/11.5/ 11.5 KV	Generati on Volt/1 1.5 kV	As per system requirement/ SLD	420 kV (rated)
iii)	Winding	2	3	2	2	-
iv)	Nos. of Phase	Single Phase (3 no. single phase units shall form a 3 phase bank)	Three	Three	Three	Three
v)	Vector Group	As per system requirement/SLD				Star with Neutral (145kv bushing) brought out
vi)	Cooling	OFAF or ODAF	ONAN/ ONAF (60/100%) (upto 130 MVA rating)	ONAN/ ONAF (80/100 %)	ONAN	
vii)	Tap Changer	As per system requirement/ Sub section B-0/SLD				
viii)	Impedance	As per system requirement/Sub section B-0, B-04/SLD				
	At75°C					
	a) Principal Tap					
	b) Other Taps					



ix)	Permissible Temperature rise over an ambient of 50 deg C (irrespective of tap)					
	a)Top Oil by thermometer	35 °C	50 °C	50 °C	50 °C(40 deg.C for upto& including 2.5MVA and 33KV rating)	40 °C
	b)Winding resistance by	40 °C	55 °C	55 °C	55°C(45 deg.C for upto&including 2.5MVA and 33KV rating)	45 °C
x)	Insulation level	As per chapter B-0, B-04 Part-B				HV:- LI:1300 kVp SI: 1050kVp PF: NA Neutral: LI: 550 kVp PF: 230kVrms
xi)	Earthing (Copper Flat)	Solidly Earthed	As per system requirement/ Sub section B-0/SLD			Refer relevant clause in this section
xii)	Termination, SC withstand time & Fault Level	As per system requirement/ Sub section B-0/SLD a) Generator Transformer, ST transformer - 3 seconds (**) b) Unit transformer - As per system sub section B-0 (**) c) All other transformers- 2 seconds (**) -The indicated values of time durations are used in transformer design for ensuring thermal stability of the transformers and are to be proven through calculations.				
xiii)	Noise level	As per NEMA TR-1				
xiv)	Loading Capability	Continuous operation at rated M VA on any tap with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS:6600/ IEC60076-7. In addition GT, ST & UT shall be able to operate at full load for at least ten (10) minutes without exceeding the calculated winding hot spot temperature of 140°C in the event of complete failure of power supply to cooling equipment applicable.				Refer relevant clause in this section
xv)	Air Core Reactance	At least 20% for HV winding for GT, ST and UT				-
xvi)	Flux Density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/- 10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following overfluxing conditions due to combined voltage and frequency fluctuations:				Refer relevant clause in this section
		a) 110% for continuous rating.				
		b) 125% for at least one minute.				
		c) 140% for at least five seconds.				
		Bidder shall furnish overfluxing char. upto 150% & 170 % for GT, ST & UT.				



Note:-

- 1). The Line Reactor shall be provided & connected with Neutral Grounding Reactor & Surge Arrestor (as applicable).
- 2). Bus Reactor will be solidly earthed.
- 3). LT Auxiliary transformers shall be 3 phase, 4 wire system with additional LVN bushing for equipment earthing.

1.02.00 NEUTRAL GROUNDING REACTOR (AS APPLICABLE)

Rated voltage from insulation strength considerations	145kV		
Rated frequency	50Hz		
No. of phases	One		
Type	ONAN or		
Dry type air core for outdoor application			
Insulation	Graded/uniform		
Insulation Class	ONAN Type -Class A Dry Type -Class F		
<u>For ONAN Type:-</u> Max. admissible temperature rise over ambient temp of 50 °C at continuous current			
a. Winding rise	50 deg. C		
b. Top oil rise	45 deg. C		
Max. continuous current (rms)	10 A		
Rated short time current (rms) (10 sec.)	60A (Max. temp. allowed 200 °C) (However NGR shall be designed for current rating of 600 amps (rms) short time current to ensure mechanical robustness which will be verified during design review)		
Rated impedance at rated short time and continuous current	As per Employer's System Requirement (shall be informed during detail engineering)		
Connection	Between neutral of Shunt (Line) Reactor and ground		
Insulation level for winding			
	Line side	Ground side	
(i)	Lighting impulse (1.2/50 microsec)withstand voltage (kVp)	550	95
(ii)	One minute power frequency withstand voltage (kVrms)	230	38



Whether neutral is to be brought out

Yes, Neutral shall be brought down upto ground level through 2 copper flat.

NGR-Neutral Bushing

24KV class (for ONAN type)

Method of grounding

Solidly connected between neutral of Shunt (Line) reactor and earth.

Mounting of NGR (Dry Type)

(i) Pedestal insulator

a) Type

Porcelain/ silicon rubber

b) Minimum creepage

613 mm

c) 1 min. Power frequency withstand voltage

38 kV rms

(d) Lighting impulse (1.2/50 microsec) withstand voltage (kVp)

110 kVp

(ii) Mounting structure

Non magnetic material

Note: The reactor shall be mounted 2.5 m above ground level to allow free and safe access at ground level for personnel.

1.03.00

SURGE ARRESTORS (AS APPLICABLE)

1.03.01

Technical Requirement

a) Rated system Voltage	145kV
b) System Neutral Earthing	Effectively Earthed
c) Installation	Outdoor
d) Rated System frequency	50Hz
e) Rated arrester voltage	120kV
f) Nominal discharge current (8/20micro-sec. wave)	10kA
g) Minimum discharge capability	5kJ/kV (Referred to rated arrester voltage corresponding to minimum discharge characteristics)
h) Continuous operating voltage at 50 deg. C	102kV
i) Max. switching surge residual voltage (1kA)	280kVp
j) Max. residual voltage at	
a. 5kA	310kVp
b. 10kA nominal discharge current	330kVp
k) Long duration discharge class	3
l) High current short duration test value (4/10 micro-sec. wave)	100 KAp
m) Current for pressure relief test	40kA
n) Low current long duration test value (2000 micro-sec.)	As per IEC
o) Min. total creepage distance of arrester housing	3625mm
p) One min. dry power frequency withstand voltage of arrester housing	275kVrms
q) Impulse withstand voltage of arrester	650kVp

housing with 1.2/50 micro-sec. wave	
r) Prospective symmetrical fault current	40kA
s) Pressure relief class	Class-A
t) R/V at 92kV rms	Less than 1000 micro volts.
u) Partial discharge at 1.05 Continuous over voltage	Not more than 50pc.
v) Seismic acceleration	0.3g

1.03.02 General requirements for Surge Arrester

- (a.) The surge arrester shall conform in general to IS 3070 (Part-I) and IEC 99-1 or IEC-TC-37 WG4, except to the extent modified in the specification and shall be in accordance with requirements under clause of Section-GEN.
- (b.) The surge arrester shall be of gapless type without any series or shunt gap.
- (c.) Arresters shall be hermetically sealed units, self supporting construction suitable for mounting on support structures.
- (d.) The contractor shall provide connections between neutral of the Line reactor, surge arrester and the neutral grounding reactor.

1.03.03 Duty Requirements for Surge Arrester

- (a.) The surge arresters shall be of heavy duty station type. It shall be physically located between the neutral of 420kV shunt reactor (as applicable) (brought out at 145kV class bushing) and neutral grounding reactor and shall be electrically in parallel with the latter.
- (b.) The surge arrester shall be capable of discharging over voltages occurring during switching of unloaded transformers and reactors.
- (c.) The surge arresters shall be capable of sparking over on severe switching surges and multiple strokes.
- (d.) The surge arrester shall be able to withstand wind load calculated at 195kg/sq.m.
- (e.) It shall be fully stabilized thermally to give a life expectancy of 100 years under site conditions and shall take of the effect of direct solar radiation.
- (f.) The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

1.03.04 Construction Details for Surge Arrester

The features and construction details of surge arrester shall be in accordance with requirements stipulated hereunder:

- (1.) The non-linear blocks shall be 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.
- (2.) 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 current in the events of arrester failure.
- (3.) The arrester shall not fail due to arrester porcelain contamination.
- (4.) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

(5.) Outer insulator shall be porcelain. Porcelain housing shall be so co-ordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

(6.) The end fittings shall be made of non-magnetic and corrosion proof material.

(7.) The arrester shall be suitable for mounting on supporting structures of tubular GI pipe.

(8) The heat treatment cycle details with necessary quality checks used for individual blocks with insulation layer formed across each block to be furnished. Metalized coating thickness for reduced resistance between adjacent discs to be furnished along with procedure for checking the same. Details of thermal stability test for uniform current distribution of current on individual disc to be furnished

1.04.00**CODES AND STANDARDS**

Transformers	IS:2026, IS:6600, IEC:60076, IS 1180
Bushings	IS:2099, IEC:60137
Insulating oil	IEC:60296
Bushing CTs	IS:2705, IEC 60185
Shunt reactor	IS 5553 & IEC 60076-6
Indian Electricity Act 2003, BEE Guideline & CEA notification	

1.05.00**OPERATIONAL REQUIREMENT****1.05.01****Transformers & Reactor**

a) Generator transformers shall be suitable for back charging. It shall be capable of being charged from HV side and kept charged continuously with no load on the LV side without any adverse impact on the transformer life.

b) Cooling requirements

i) Generator Transformers:-GT (including Spare GT) cooling shall be effected by use of a number of detachable type unit coolers. Capacity of each unit cooler shall be limited to maximum of 20 % of the total cooling requirements. At least one standby cooler of rating equal to that of Main cooler shall be provided. The coolers shall be tank mounted. There shall not be flow of directed air towards tank body. The orientation of coolers shall be subject to Employer's approval. Total capacity of unit coolers furnished for each transformer shall be minimum 120% of actual requirements. All oil pumps (cooler) shall be located at the cooler outlet pipe connected at the bottom of the tank.

ii) UT:-Transformers shall be provided with detachable type tank mounted radiator banks with 100% cooling capacity. Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration, also fan shall be protected by galvanized wire guard. Each radiator bank shall have lifting lug, air release plug, top & bottom filling/shut-off valves, oil pumps & oil flow indicator (as applicable), filter valves, drain valve/plug etc. The number and capacity of cooling fans with radiator bank shall be such that outage of any fan does not reduce the continuous rating. Automatic operation/control of fans shall be provided (with temp. change) from contacts of winding temp. indicator.

iii) ST (Above 130MVA): The 2 x 100%, centrifugal or axial in line oil pumps (out of which one pump shall be standby) shall be provided with each radiator bank. Measures shall be taken to prevent maloperation of Buchholz relay when both oil pumps are simultaneously put into service. The pump shall be so designed that upon failure of power of supply to the pump motor, the pump impeller will not limit

the natural circulation of oil. 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 reverse flow of oil/loss of oil flow.

- iv) The maximum oil velocities shall be such that it does not lead to static discharge inside the transformer. It shall be possible to operate all installed cooling equipment simultaneously without any danger.
 - v) For Auxiliary Transformers & Neutral Grounding Reactor the radiators (if applicable) shall be detachable type, mounted on the tank. Each radiator shall be provided with a drain plug/valve at the bottom, an air release plug at the top, shut off valve at each point of connection to the tank.
 - vi) Shunt Reactor : - The radiator bank of the Shunt Reactor shall be tank mounted. Each radiator shall be provided with a drain plug/valve at the bottom, an air release plug at the top, shut off valve at each point of connection to the tank.
 - vii) The radiators shall be made of Hot Dipped Galvanized Steel conforming to **ISO 12944-5:2018, Table D.1, System no. G5.05.**
- c) Other Requirement
- i) Phase to Earth clearances (400 KV): 3500 mm
 - ii) The impedance of each single-phase unit (GT) shall have to be identical as far as possible and variation of impedance of any single-phase unit (GT) shall be within $\pm 5\%$ of impedance of other two units.
- d) OLTC (as applicable)
- i) Local control, both manual and electrical
 - ii) Remote electrical control with necessary relays (as required)
 - iii) Safety interlocks and protection
 - iv) Remote Tap position signal
 - v) Tie-in resistors requirement, if any, may be confirmed and provided.
- e) Permissible maximum losses for 420 kV, 315 MVA Generator Transformer, shall be as per Annexure-A of CEA standard specification and technical parameters for Transformers and Reactors (66kV and above voltage class).
- f) LT Auxiliary outdoor transformers up to and including 2500KVA, 11kV shall have maximum losses of STAR-2 rating or better as per latest BEE guideline. The outdoor transformer up to 2500KVA, 11kV shall also comply with latest IS:1180.

1.05.02

Shunt Reactor

- a) Shunt reactor will be connected to the 400 KV transmission system for reactive load compensation. Shunt reactor shall be capable of controlling the dynamic over voltage occurring in the system due to load rejection.
- b) Shunt reactor shall be capable of operating continuously at a voltage of 5% higher than their rated voltage without exceeding hot spot temperature of 150 deg C at any part of reactor.
- c) The reactor shall be subjected to switching surge over voltage upto 2.5 pu & temporary over voltage of the order of 2.3 pu for few cycle followed by power frequency over voltage upto 1.5 pu. The reactor must withstand the stresses due to above transient



dynamic conditions which may cause additional current flow as a result of changed saturation characteristic / slope beyond 1.5 pu voltage.

- d) Range of constant impedance shall be upto 1.5 p.u. voltage. (The contractor shall furnish complete saturation characteristics of the reactor upto 2.5 p.u. voltage)
- e) Ratio of zero sequence reactance to positive sequence reactance shall be between 0.9 & 1.0.
- f) Temperature rise shall be guaranteed when Shunt reactor is operating at 420 KV.
- g) Vibration level at rated voltage & frequency shall not be more than 200 microns peak to peak. Average vibration shall not exceed 60 microns peak to peak. Tank stresses shall not exceed 2.0 Kg/mm² at any point on the tank.
- h) The crest value of the 3rd harmonic component in phase current shall not exceed 3% of the crest value of fundamental, when energized at rated voltage with sinusoidal waveform.
- i) Permissible current unbalance among different phases shall be +/-2% & tolerance on current shall be 0 to (+)5%.
- j) The neutral reactors are required for grounding of the neutral point of shunt reactors (as applicable) to maintain the secondary arc current and recovery voltage to a minimum value. The ohmic values of neutral grounding reactors shall be as mentioned in elsewhere in the specification.
- g) Permissible maximum losses for 420 kV, 125 MVAR Shunt Reactor shall be as per Annexure-A of CEA standard specification and technical parameters for Transformers and Reactors (66kV and above voltage class).

1.06.00 DESIGN AND CONSTRUCTIONAL FEATURES

1.06.01 NTPC may at their discretion have design review done to check the design of the transformers / shunt reactor by NTPC/their consultant.

1.06.02 Tank

- a) Tank shall be of welded construction & fabricated from tested quality low carbon steel of adequate thickness.
- b) The main tank body including tap changer, radiators (except for Auxiliary transformers) and coolers shall be capable of withstanding full vacuum. Tank shall be provided with suitable lifting lugs, minimum 4 jacking pads & haulage holes for wheeling in all four directions. The GT Tank shall be Bell type. Shunt Reactor tank shall preferably be Bell type. Bell Type Tank bolted joint shall be at about 500 mm above bottom of the tank and shall have 4nos. of lifting pads on bell Tank cover so as to lift it for rim gasket replacement.
- c) GT, ST, UT & transformers located at Transformer yard shall be mounted on detachable type bi-directional rollers for rail gauge of 1676mm. Auxiliary transformers shall have suitable bi-directional skids, however auxiliary transformers above 2 MVA shall be provided with four no. of bi-directional detachable flat rollers. Suitable locking arrangement shall be provided to prevent accidental movement of transformer. The shunt reactor shall be mounted on concrete with foundation directly, however bidirectional wheel (for rail gauge of 1676mm) shall be provided to facilitate the movement of reactor.

d) At least two adequately sized inspection openings, one at the each end of the tank for easy access to bushings and earth connections& suitable manhole shall be provided.

(e)The base of each tank shall be so designed that it shall be possible to move the complete transformer/ reactor unit by skidding in any direction without damage when using plates or rails and the base plate shall have following minimum thickness. (For GT/ST/Reactor only)

Length of tank	Minimum Thickness (mm)
Flat bases Over 2.5 m but less than 5m	20
Flat bases Over 5 m but less than 7.5m	26
Flat bases Over 7.5 m	32

1.06.03

Core

Transformer	Requirement
GT, ST,UT	Core shall be high grade, non-ageing, cold-rolled, super grain oriented silicon steel laminations known as Hi B grade steels or equivalent. The insulation of core to tank, tank to clamp and clamp to core shall be able to withstand a voltage of 10 KVrms (for GT, ST)& 2 KVrms (for UT) for 1 min in air. To facilitate testing of above during pre-commissioning stage, the core/clamp earthing has to be done outside the tank with suitable bushings.
Shunt Reactor & Neutral grounding Reactor	The core shall be constructed from high grade, non-ageing, cold rolled, grain oriented silicon steel laminations. 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. The Shunt reactor shall be of either gapped core type or magnetically shielded air core type construction.
Auxiliary Transformers	Core shall be high grade non-ageing cold rolled super grain oriented silicon steel laminations of M4 grade or better quality. The core isolation shall be able to withstand a voltage of 2 kV (rms.) for 1 minute in air.

1.06.04

Insulating oil

No inhibitors shall be used in the transformer oil. The oil supplied with transformers/ reactor shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

S.No.	Property	Permissible values
1.	Kinematic Viscosity, mm ² /s	≤ 12 at 40 ° C ≤ 1800.0 at (-)30 ° C
2.	Flash Point, ° C	≥ 140° C
3.	Pour point, ° C	≤ (-)40 ° C
4.	Appearance	Clear , free from sediment and suspended matter
5.	Density kg/dm ³ at 20 ° C	≤ 0.895
6.	Interfacial Tension N/m at 25° C	≥ 0.04
7.	Neutralisation value, mgKOH/g	≤ 0.01

S.No.	Property	Permissible values
8.	Corrosive sulphur	Non Corrosive
9.	Water content mg/kg	≤30 in bulk supply ≤40 in drum supply
10.	Anti oxidants additives	Not detectable
11.	Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass	≤ 1.2 ≤ 0.8
12.	Breakdown voltage As delivered, kV After treatment, kV	≥ 30 ≥ 70
13.	Dissipation factor, at 90° C And 40 Hz to 60 Hz	≤ 0.005
14.	PCA content	≤1%
15.	Impulse withstand Level, kVp	≥ 145
16.	Gassing tendency at 50 Hz after 120 min, mm ³ /min	≤ 5

Subsequently oil samples shall be drawn at:

Sr. No.	Parameters	Before filling in main tank at site & tested for	Prior to energization at site for following properties & acceptance norms:	Applicability
i)	BDV	60 kV (min)	60 kV (min)	Applicable for all Transformers & Reactor.
ii)	Moisture content	10 ppm (max.)	10 ppm (max.)	
iii)	Tan delta at 90 deg. C	0.005 (max.)	0.05 (max.)	Applicable for Transformers/Reactor (16 MVA & above).
iv)	Interfacial tension	0.04 N/m(min)	0.035 N/m (min)	

1.06.05

Windings

The conductors shall be of Electrolytic grade copper. All Windings of 66kV and below shall have uniform insulation. The contractor shall ensure that windings are made in dust proof & conditioned atmosphere. All windings of GT, ST, UT and Reactors shall have thermally upgraded paper covering insulation.

For GT, ST & Shunt Reactor, winding paper moisture shall be less than 0.5%.

1.06.06

Oil preservation

Main tank and OLTC (if applicable) shall be provided with conservator tanks of adequate capacity for expansion of oil from minimum ambient to 100 deg.C. The equipment rated 7.5MVA and above shall be provided with air bag breathing through indicating type cobalt free silica gel breather with transparent enclosure (refer fittings clause for breather type applicable for GT & Shunt Reactor). However conventional type conservator with indicating type cobalt free breather (transparent enclosure) shall be offered for transformer below 7.5 MVA. However conventional type conservator with indicating type cobalt free breather (transparent enclosure) may be offered for neutral grounding reactor.

For GT, ST and Reactor, Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be externally installed on the top of conservator to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

1.06.07

Bushings



- (g.) The electrical & mechanical characteristics of bushings shall be in accordance with IS: 2099, IS: 3347, IS: 12676 & IEC: 60137.
- (h.) Bushings below 52 kV shall be with porcelain insulator and shall be of oil communicating / OIP (non-oil communicating type) / epoxy RIP type. All condenser bushings shall be non-communicating type.
- (i.) Bushings from 52 kV upto 420 kV class (including 52 kV and 420 kV class), shall be RIP (Resin Impregnated Paper) Type with composite insulator. It shall be provided with Tap for Capacitance and Tan delta test. All composite resin impregnated bushings (RIP) shall be provided with provision for long term storage to protect from moisture and rodents. The oil side shall be provided with tank which can be filled with oil. Tank shall have necessary provision for oil filling, level gauge etc. Suitable covering to be provided on air side to protect from any damage. The arrangement shall be suitable for storage in horizontal/ vertical direction in outdoor location.
- (j.) The oil end dimension of RIP bushing shall be same for all bushings of similar voltage rating.
- (k.) All condenser bushings shall be non-communicating type.
- (l.) Condenser type bushings shall be provided with:
 - i) Oil level gauge
 - ii) Oil filling plug
 - iii) Tap for capacitance and Tan delta test
- (m.) Clamps & fittings shall be of hot dip galvanized steel.
- (n.) Bushing & fittings shall be provided with vent pipes that shall be connected to route any gas collection through the Buchholz relay.
- (o.) No arcing horns shall be provided on the bushings.
- (p.) LV Bushing palm shall be Silver/Tin plated.
- (q.) Oil end portion of 420 KV Class RIP bushings shall be as per tender drg. no. 0000-501-POE-A-006, rev.-0.

Winding and Bushing details:

1. **Generator Transformer (GT) – as per Annexure-A of** of CEA standard specification and technical parameters for Transformers and Reactors (66kV and above voltage class).

2. STATION TRANSFORMER

Winding Details						
S.No.	Parameter	Unit	HV	HVN	LV1 & LV2	LV1N & LV2N
1.	Lightning impulse withstand voltage	kVp	1425	95	75	75
2.	CW Lightning impulse withstand voltage	kVp	1570	-	82.5	-
3.	Switching impulse withstand voltage	kVp	1175	-	-	-
4.	One min power frequency withstand voltage	kV	630/38*	38	28	28
5.	Winding connection	-	Star	Solidly grounded	Star	through NGR.

* In case of non-uniformly insulated.

Bushing Details						
S.No.	Parameter	Unit	HV	HVN	LV1& LV2	LV1N & LV2N
1.	Rated Voltage	kV	420	36	12	12
2.	Rated Current (min.)	A	800	800	5000	5000
3.	Lightning impulse withstand voltage	kVp	1550**	170	75	75
4.	Switching impulse voltage	KVp	1175			
5.	One min power frequency withstand voltage	kV	750	77	30	30
6.	Minimum total creepage distances	mm	13020	1116	372	372

**The bushing shall be suitable for chopped wave lightning impulse test on transformer at 1570KVp.

3. UNIT TRANSFORMER

Winding Details					
S.No.	Parameter	Unit	HV	LV	LVN
i)	Highest System Voltage	kV	36	12	-
ii)	Lightning impulse withstand voltage	kVp	170	75	75
iii)	One min power frequency withstand voltage	kV	70	28	28
iv)	Winding connection	-	Delta	Star	through NGR.

Bushing Details					
S.No.	Parameter	Unit	HV	LV	LVN
i)	Rated Voltage	kV	36	12	12
ii)	Rated Current (min.)	A	2500	4000	4000
iii)	Lightning impulse withstand voltage	kVp	170	75	75
iv)	One min power frequency withstand voltage	kV	77	30	30
v)	Minimum total creepage distances	mm	900	300	300

4. **Shunt Reactor** – As per Annexure-A of CEA standard specification and technical parameters for Transformers and Reactors (66kV and above voltage class).

1.06.08

Bushing CTs

Shall be of adequate rating for protection as required, WTI etc. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted. All CT terminals shall be provided as fixed type terminals on the M. Box/CCC/CMB to avoid any hazard due to loose connection leading to CT opening or any other loose connection in power circuit. In no circumstances Plug In type connectors shall be used for CT & Power connection.

1.06.09

Tap changer (as applicable)

- i) Measurement for Tan delta values of OCTC & OLTC to be done before installing in the 132 kV & above class transformer.



- ii) The OLTC chamber oil shall not come in contact with main tank oil.
- iii) Tap Changer drive marshalling box shall be provided for GT (as applicable), ST & UT.
- iv) For GT tap changer shall be provided with out of step digital position indicator showing mismatch between tap position of transformers in three phases, also an analog signal (4-20 mA) for tap position of transformer.

1.06.10

Marshalling box/CCC (Cooler Control Cabinet) /CMB (common M. Box)

- i) Each GT shall be provided two different boxes; one for housing cooler controls named as cooler control cabinet (CCC) and separate box for housing OTI, WTI, CT signals & Protective equipment signals etc. named as Marshalling Box (MB).

Each Shunt reactor shall be provided with one marshalling box housing the OTI, WTI etc. for one unit. For other transformers & NGR 1 no. M. Box shall be provided for each unit.

- ii) One common marshalling box (CMB) shall be provided for each set of three single phase Transformers/Shunt Reactor. These boxes shall not obstruct removal of any of the transformer phases. For GT, CMB shall have two compartments one for AC power supply arrangement and other for CT and control cable.
- iii) M. Box/CCC/CMB shall be of stainless steel (SS-316 or better), at least 2.5 mm thick, dust and vermin proof provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. Marshalling Box of all transformers shall be preferably Tank Mounted. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber. Bidder to refer tender drg. ref. no.-0000-501-POE-A-005, rev.-0 regarding general outdoor layout for reference. The gasket used shall be of neoprene rubber. Also Marshalling Box, CCC, CMB gland plate shall be at least 450 mm above ground level.
- iv) GT, ST & UT shall be provided with two auxiliary power supplies, 415V, three phase, 4 wire shall be drawn from two separate boards for the M. Box/cooler control cabinet-CCC/ Common Marshalling Box-CMB. In case of one power supply failure, loads shall be automatically transferred to other. The supplier shall derive AC feeders for OLTC cabinet (if applicable) after suitable selection at M. Box. In case of GT supply changeover circuit (for selection of one power feeder) shall be at CCC (for each phase).
- v) Each cooling fan and pump motor (as applicable) shall be provided with isolating switch, starter, thermal overload, single phase preventer and short circuit protection. For GT, all power contactor used for pump & fan motors shall be latch type.
- vi) The Automatic operation/control of fans/pumps (as applicable) shall be provided (with temp. change) from contacts of winding temp. Indicator.
- vii) For auxiliary transformer, wiring scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.
- viii) TB shall be stud type for all CT & Power connections with ring type lugs.
- ix) For GT following is also applicable:-
 - (a.) Common Marshalling Box & CCC shall be 4 door arrangement (2 front+2 back door) with minimum length of 2000/1500 mm, minimum width of 800/650 mm, maximum height of 2100/2100 mm respectively for CMB & CCC. CMB gland plate provided for employer's use shall be of minimum equivalent size of 650 (L) x 650 (W).



- (b.) In CCC/CMB, power cable termination shall be placed atleast 300 mm above gland plate.
- (c.) Terminal board rows shall be spaced adequately not less than 100mm apart to permit convenient access to wires and terminations. No components (except heater & it's switch, light & sockets) shall be mounted on side & top wall of Marshalling Box, CCC & CMB e.g. relay, timer, contactors, MCBs. TBs etc.
- (d.) CMB incomer shall be suitable for at least 1Cx300 sq mm armour aluminium cable per phase as incomer. Suitable space for termination & bending of cable to be provided.
- (e.) At least 50 sq. mm armoured copper cable shall be provided by bidder for 3-phase power supply distribution from CMB to CCC (each phase).
- x) Terminal block numbering for ST, UT, GT & Aux. transformer shall be made in line with tender drawing no.0000-501-POE-A-002, 0000-501-POE-A-003& 0000-501-POE-A-004 & 0000-203-PVE-B-001 respectively.

1.06.11

Valves

- (t.) All valves upto and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings.
- (u.) Sampling & drain valves should have zero leakage rate.

1.06.12

Gaskets

- a) For GT, ST, UT&Shunt Reactor all the gasket shall be weather proof & hot oil resistant of 'O' ring of Nitrile rubber for all valves, flanges, HV, LV & Neutral Turrets, Bushings, Tank rim, etc. For this, all the flanges shall be machined. However GT,LV turret to Tank joint shall be provided with "Fluor elastomers" cord gasket.
- b) For Auxiliary Transformers gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
- c) For Neutral Grounding Reactor gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
- d) If gasket is compressible, metallic stops shall be provided to prevent over compression.
- e) The gaskets shall not deteriorate during the life of transformer/reactor if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer/reactor. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

1.06.13

Transformer/Shunt Reactor Transportation

Transportation shall be N2/Dry Air/Oil filled. GT,ST, UT&Shunt Reactorshall be transportedwith sufficient number (minimum two nos.) of impact recorders with necessary arrangement to maintain N2/Dry air pressure (as applicable) during transit and storage.

1.06.14

PAINTING

PARTS NAME	TYPE OF PAINT	NO.OF COATS	TOTAL DFT
Inside of tank and accessories (except CCC, CMB & M Box)	Oil & heat resistant fully glossy white	One coat	Atleast 30 micron
External surface of transformer and accessories (except coolers & radiators)	Chemical resistant epoxy zinc phosphate primer, MIO (Micaceous iron oxide) as intermediate paint followed by polyurethane finish paint (RAL 5012 Blue)	One coat each	Atleast 100 micron
External Cooler, Radiator surface	ISO 12944-5:2018, Table D.1, System no. G5.05 of priming and painting with high quality full glossy outer finish paint (RAL 5012 Blue)	As per ISO 12944-5:2018, Table D.1, System no. G5.05	As per ISO 12944-5:2018, Table D.1, System no. G5.05
Internal Radiator surface	Hot oil proof, low viscosity varnish and subsequent flushing with transformer oil	---	---

1.07.00

Monitoring System of GT

The supervision, control and communication of various operating conditions and condition monitoring of GT shall be done through SAS.

1.08.00

Neutral Earthing Arrangement

- i) HV neutral terminals of winding of three single phase GTs shall be connected to an overhead common copper grounding bars, supported from tank and firewalls by using porcelain insulators. Puncturing of firewall shall not be permitted. In case of Generator Transformers, after forming neutral it shall be solidly grounded via 2 nos. copper flats.
- ii) The neutral of Transformers/Reactor shall be brought through insulated support from tank to the ground level at a convenient point with copper flat, for connection to ground network (as applicable). However neutral may be connected to NGR as per system requirement.

1.09.00

NGR (Neutral Grounding Resistor) (As per system requirement)

1.	Resistance at 50°C	As per system requirement
2.	Rated current	600A for 10 seconds
3.	Application	Neutral Grounding of Transformers as per system requirement
4.	Service	Outdoor
5.	Resistor material & connection	Punched stainless steel grid element type

6.	Max allowable temp rise over amb. of 50°C	350 deg. C
7.	Mounting	As per system requirement
8.	Power frequency level	As per system requirement
9.	Stacking	Various sections comprising the neutral grounding resistor shall be capable of being stacked one above the other.
10.	Enclosure	NGR shall be housed in a 2.5 mm thick sheet steel enclosure & DOP IP-33.A heating circuit with Thermostat to be provided inside the enclosure to control humidity.
11.	Mounting Structure	The Contractor shall supply and erect a galvanized structure to support the NGR enclosure so that the base of the enclosure shall be at a minimum height of 2.4M above ground level.

1.10.00
FITTINGS

Following fittings shall be provided with Transformers, Shunt Reactor& Neutral Grounding Reactor (as applicable)covered under this specification.

a)	-Conservator for main tank with MOG (with low oil level alarm contact), drain valve &indicating type free Cobalt free breather with transparent enclosure (maximum height 1400 mm above rail level)etc. Aircell (for 7.5 MVA & above). -Conservator for OLTC tank with Oil level gauge, indicating type Cobalt free Breather & drain valve.
b)	-Bucholz relay (magnetic type), double float type with alarm and trip contacts(with plug & socket type arrangement), alongwith suitable gas collecting device. - Oil surge relay to be provided for OLTC.
c)	- For 2 MVA & above rating transformer/reactor,, minimum two numbers of spring operated PRD (with trip contacts with plug & socket type arrangement) with suitable discharge arrangement for oil shall be provided. Armored cable be used between PRD to Marshalling box. PRD shall have DOP of IP-67. Plugin type connector shall be provided for proper sealing for terminating cables/ glands. - For transformers below 2 MVA, diaphragm type explosion vent shall be provided.
d)	OTI & WTI shall be 150 mm dial type with alarm and trip contacts with max. reading pointer & resetting device. (maximum height 1500 mm above rail level) For GT, ST, UT&Shunt Reactor WTI shall be provided for all windings, also PT-RTD with 4-20 mA signals shall be provided with OTI & WTI of these transformers/Shunt Reactor.
e)	Top& bottom filter valves with threaded male adapters, bottom sampling valve, drain valve/sludge removal valve at the bottom most point of the tank.
f)	Air release plug, bushing with metal parts & gaskets, terminal connectors on bushings(as applicable)& surge arrestor (as applicable).
g)	Prismatic/toughened glass oil gauge for transformers and OLTC chamber.
h)	Followings items are as applicable:- Bi-directional wheel& skids, M. Box, OLTC, OCTC, Bushing CTs, Insulating Oil, Fans, pumps& oil flow indicator, Cooling equipment, Valve Schedule Plate.



CLAUSE NO.

TECHNICAL REQUIREMENTS

i)	Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs, additional 4 nos. lifting lugs for bell tank cover, inspection cover, manhole, Bilingual R&D Plate, Terminal marking plates, two earthing terminal setc.
j)	Bolts & nuts (exposed to atmosphere) shall be galvanized steel/SS.
k)	Rain hoods to be provided on Buchholz, MOG & PRD. Entry points of wires shall be suitably sealed.
l)	1 no. Rapid Pressure Rise relay for each GT, ST, UT & Shunt Reactor.
m)	For GT & Shunt Reactor:- -Regenerative Maintenance free Breather: Each GT & Shunt Reactor shall be equipped with Online non Carcinogenic regenerative type breather which shall regenerate silica gel automatically using moisture sensors, with suitable alarm/indication signal. OLTC conservator breather shall be provided with conventional non-carcinogenic indicating type breather.
n)	-Online moisture removal system (1 for each three phase bank) - For each GT:- Online DGA, conservator aircell rupture relay.
The fittings listed above are only indicative and other fittings, which generally are required for satisfactory operation of the Transformers, Shunt Reactor & Neutral Grounding Reactor (as applicable) are deemed to be included.	

1.11.00 Testing Requirements

1.11.01 Apart from the type test listed in this specification, following components to be supplied shall be of tested design and submit the reports for approval.

- (x.) All type tests on 132 KV and above Bushings as per IEC 60137
- (y.) All type test on OLTC as per IEC 60214 (wherever applicable)
- (z.) Neutral Grounding Resistors

1.01.02 Type tests criteria for Auxiliary oil filled transformers rated upto 16MVA, 11kV (only type test report has to be submitted)

A)) The Type Test reports should be of a transformer which is generally similar to the transformer being offered as per IEC 60076-5, Annexure-B and also identical to the offered transformer in the following aspects:

- i) Voltage ratio
- ii) MVA/KVA rating
- iii) Percentage Impedance
- iv) Internal design
- v) Type of tap changer equipment
- vi) Cooling arrangement
- vii) Temperature rise
- viii) Individual and total loss values of the offered transformer shall be same as that indicated in the GTP of transformer for which Type Test Reports are submitted.

B) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

1.11.02 Each transformer/reactor shall be completely assembled with all fittings & accessories meant for the particular transformer/reactor before offering for inspection & testing by Employer.

1.11.03 **ROUTINE / TYPE TESTS ON TRANSFORMERS:**

I) ROUTINE TEST

S. N.	Transformer Type	GT (1-PH)	ST(3-ph)	UT (3- PH)	Auxiliary Trans.
	Voltage Class	400 kV Class	400kV Class	Um ≤ 72.5kV	Um ≤ 72.5kV
1.	All routine test in accordance with IEC 60076 shall be carried out in all the transformers.	√	√	√	√
2.	Measurement of Voltage Ratio & phase displacement (as per IEC 60076-1)	√	√	√	√
3.	Measurement of winding resistance on all the taps (as per IEC 60076-1)	√	√	√	√
4.	Vector group and Polarity Check (as per IEC 60076-1)	√ (polarity only)	√	√	√
5.	Magnetic Balance and Magnetising Current Test	X	√	√	√
6.	Measurement of no load current with 415 V, 50 hz AC supply	√	√	√	√
7.	Measurement of no load losses and current at 90%, 100% & 110% of rated voltage (as per IEC 60076-1)	√	√	√	√
8.	Load Loss & Short Circuit Impedance Measurement on principal & Extreme Taps	√	√	√	√
9.	IR measurement (As per IEC 60076-1)	√	√	√	√

S. N.	Transformer Type	GT (1-PH)	ST(3-ph)	UT (3- PH)	Auxiliary Trans.
10.	2KV / 10 KV core isolation (core-clamp, clamp-tank, core-tank)	√ (10KV)	√(10kv)	√(2KV)	X
11.	Measurement of capacitance & tan delta to determine capacitance between winding & earth. (for 132 kV & above class transformer, tan delta should not exceed 0.5% at 20 °C, also refer Note-iv below)	√	√	√	√
12.	Dielectric tests shall be carried out as per IEC 60076-3.	√	√	√	√
13.	Applied Voltage Withstand Test (as per IEC 60076-3)	√	√	√	√
14.	Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3)	√	√	X	X
15.	Lightning impulse test on LV Neutral	X	√	X	X
16.	Switching impulse test (as per IEC 60076-3)	√	√	X	X
17.	IVPD test as per IEC 60076-3 shall be conducted (for U1 & U2 level refer Note & Table given below)	√	√	X	X
18.	LTAC test as IEC 60076-3 (also refer Table given below)	X	√	X	X
19.	Induced overvoltage test	X	X	√	√
20.	Repeat no load current/loss measurement & IR after	√	√	√	√

S. N.	Transformer Type	GT (1-PH)	ST(3-ph)	UT (3- PH)	Auxiliary Trans.
	completion of all electrical test				
21.	Oil leakage test on completely assembled transformer along with unit coolers/ radiators (as per relevant clause of this sub section)	√	√	√	√
22.	Jacking test followed by D.P. test	√	√	√	√
23.	Frequency Response Analysis test	√	√	√	X
24.	Marshalling Box/Cable box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.	√	√	√	√
25.	IR measurement on wiring of Marshalling Box.	√	√	√	√
26.	Temperature Rise test at a tap corresponding to maximum losses and at minimum 110 % of rated current of corresponding tap. Gas chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IEC:61181. Infra red thermography shall be done	√**	X	X	X

S. N.	Transformer Type	GT (1-PH)	ST(3-ph)	UT (3- PH)	Auxiliary Trans.
	during temp rise test, same needs to be measured during last hour of oil rise stabilization. Result shall be recorded for future reference.				
27.	Measurement of power taken by the fans and oil pumps	√	X	X	X
28.	Measurement of insulation power factor and capacitance of bushings	√	√	X	X
29.	Tan delta of bushing at variable frequency (Frequency Domain Spectroscopy)	√	√	X	X
30.	Check of the ratio and polarity of built-in current transformers	√	√	X	X
31.	Short duration heat run test (Not applicable for unit on which temperature rise test is performed)	√	√	X	X
32.	Over-excitation test (applicable for 765 kV transformer only)	X	X	X	X
33.	Measurement of dissolved gases in dielectric liquid	√	√	X	X

II) TYPE TEST (#)

S. N.	Transformer Type	GT (1-PH) 400 kV Class	ST 400kV Class	UT (3-PH) Um ≤ 72.5kV	Auxiliary Trans. Um ≤ 72.5kV
	Voltage Class				
1.	LTAC test as IEC 60076-3 (also refer Table given below)	√	X	X	X
2.	Lightning impulse(Full & Chopped Wave) test on windings (as per IEC 60076-3)	X	X	√	√
3.	Lightning impulse test on Neutral	X	X	√	√*
4.	Short circuit test (special test) as per IEC 60076-5. In addition, For GT, ST & UT :- i) DGA & FRA shall also be conducted before & after S.C. test. ii) Physical inspection of transformer to be done before S.C. Test in presence of NTPC inspector and photographs to be taken for reference.	√	√	√	√
5.	Temperature Rise test at a tap corresponding to maximum losses. Gas Chromatography shall be conducted on oil sample taken before & immediately after temp. rise test. Gas analysis shall be as per IS: 9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC: 60599). For ST, DGA results shall be interpreted as per IEC 61181. For ST& UT, infrared thermography shall be done during temp rise	X	√	√	√

S. N.	Transformer Type	GT (1-PH)	ST	UT (3-PH)	Auxiliary Trans.
	test, same needs to be measured during last hour of oil rise stabilization. Result shall be recorded for future reference.				
6.	Zero sequence impedance measurement test(Special test)	X	√	√	X
7.	Measurement of power taken by the fans & pumps (as applicable)	X	√	√	X
8.	Measurement of harmonics of no load current (special test)	√	√	√	X
9.	Measurement of acoustic noise level as per NEMA TR-1 (special test)	√	√	√	√
10.	Measurement of transferred surge on tertiary due to HV lightning impulse and IV lightning impulse	√	X	X	X
11.	Measurement of transferred surge on tertiary due to HV Switching impulse and IV Switching impulse	√	X	X	X
12.	Overload testing in short-circuit method (applicable for 765 kV transformer only)	X	X	X	X

NOTE:-

- i) (#) All the type/special tests & temperature rise test shall be conducted after performing Short Circuit Test. If Tank Vacuum & Pressure Test (For UT and Auxiliary Transformers) is to be carried out then it shall be conducted before SC test.
- ii) (√) mark indicates test to be carried out and (X) mark indicates test need not to be carried out.
- iii) The power factors should not exceed 0.5% (at 20 °C). However in case of deviation from limiting values the same shall be resolved in line with IEEE Std-62.
- iv) (*) this test is applicable on Transformer neutral earthed thru NGR.
- v) For IVPD Test U1 & U2 are as follows:-
 - a) $U1(\text{Enhancement Voltage}) = 1.8U_m/\sqrt{3}$, $U2(\text{PD measurement voltage}) = 1.6U_m/\sqrt{3}$ (for $U_m < 400 \text{ KV}$)

- b) U1(Enhancement Voltage)=510KV & U2(PD measurement voltage)= 460KV
(for 400KV class Transformer)
- vi)**During Infra red thermography test of GT, the temperature of any part of tank shall be limited to 110 deg C.

Table-1	
Test	IVPD
Max allowed change in PD after voltage enhancement	100 pC
The background noise level shall not exceed 50pC.	

Table-2 (Test Voltage for LTAC)	
Highest System Voltage (Um) for 400 kv class	420 KV
U1(LTAC Voltage level)	630 KV

Table-3 Test Voltage for LTAC	
Highest System Voltage (Um)	145 KV
U1 (LTAC Voltage level)	275KV

1.11.04

ROUTINE / TYPE TESTS ON SHUNT REACTOR& NEUTRAL GROUNDING REACTOR(as applicable) :

1) Routine Tests

a) Shunt Reactor

All the routine tests listed in IEC-60076-6/IS-5553 (Part I&II) shall be carried out on the Shunt Reactor. In addition the following tests shall also be carried out on Shunt Reactor:-

- Switching impulse on line terminals (IS:2026 Part III)
- Inducted over-voltage with partial discharge measurement IS:2026, Part- III.
- Oil leakage test on complete assembled reactor along with radiators.(as per relevant clause of this sub section)
- Lightning impulse test on all phases.
- Vibration and stress measurement test.
- FRA test.
- Marshalling Box: It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.
- Measurement of capacitance and tan-delta to determine capacitance between winding and earth. (tan delta should not exceed 0.5% at 20 deg C, refer Note below).
- Measurement of insulation resistance & Polarization index.
- Measurement of insulation power factor and capacitance of bushings.
- Tan delta of bushings at variable frequency (Frequency Domain Spectroscopy).
- Core assembly dielectric and earthing continuity test.
- High voltage withstand test on auxiliary equipment and wiring after assembly.
- Measurement of dissolved gasses in dielectric liquid.
- Two-hour excitation test (except type tested unit).
- Appearance, construction and dimension check.
- Measurement of Mutual inductance on 3-phase reactor.

NOTE:-The power factors should not exceed 0.5% (at 20 °C). However in case of deviation from limiting values the same shall be resolved in line with IEEE Std-62.

b) Neutral Grounding Reactor(as applicable)

In addition to the routine tests listed in the IEC-60076/IS-5553 following tests shall also be carried out on Neutral Grounding Reactor (Oil filled):

1. The volt-current characteristics test shall also be carried out on each neutral grounding reactor preferably at least up to short time rated current. Calculated value of hot spot temperature shall be furnished by the contractor.
2. Measurement of insulation resistance.
3. Measurement of Capacitance & Tan delta of winding insulation to earth & bushing.
4. Lightning impulse test.
5. Oil leakage test.
6. Appearance, construction and dimension check.
7. High voltage withstand test on auxiliary equipment and wiring assembly.
8. Measurement of vibration at rated continuous current.
9. Measurement of Loss.

For dry type Neutral Grounding Reactor: In addition to the routine tests listed in the IEC-60076/IS-5553. The volt-current characteristics test shall also be carried out on each neutral grounding reactor preferably at least up to short time rated current. Calculated value of hot spot temperature shall be furnished by the contractor

2) Type Tests

(a) Shunt Reactor

Following type tests shall be conducted on one Shunt reactor (of each type/rating):

(i) Test of temperature rise (as per IEC-60076-6)

Gas chromatographic analysis test on oil shall be conducted along with this test. The sampling shall be in accordance with IEC-567. For the evaluation of the gas analysis in temperature rise test, the procedure shall be as per IS:9434 (based on IEC-567) and results interpreted as per IEC 61181. Infra red thermography shall be done during temp rise test. Result shall be recorded for future reference.

(ii) Measurement of zero-sequence reactance-As per IEC 60076-6.

(iii) Measurement of acoustic noise level – As per IEC 60076-6.

(iv) Lightning impulse test on neutral –IEC 60076-3.

(v) Measurement of knee point voltage.

(b) Neutral Grounding Reactor

The following type test shall be conducted on one Neutral grounding reactor:

(i) Temp. rise test

(iii) Short time current test & measurement of impedance at Short time current.

(iv) Measurement of acoustic sound level.

TESTS ON SURGE ARRESTERS(as applicable)

In continuation to the requirements stipulated, surge arresters shall conform to type tests, and shall be subjected to routine and acceptance tests in accordance with IEC-99-4.

Surge arrester shall be subjected to following additional acceptance tests.

Construction check (visual check)

Measurement of insulation resistance by 1kV Megger

1.11.05

TANK TESTS**(a) Routine tests****(1) Oil leakage test on assembled transformers**

All tank and oil filled compartment shall be tested for oil tightness by being completely filled with oil of viscosity not greater than that of specified oil at the ambient temperature and applying pressure equal to the normal pressure plus 35 kN/m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 6(six) hours during which time no sweating shall occur. For GT,ST, , UT & Shunt Reactor this test shall be repeated as a pre-commissioning test at site for 24 hours.

(2) Vacuum test

For GT, ST&Shunt Reactor tank of each type shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 kN/m² absolute (25 torr) for one hour. The permanent deflection of the 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

(3) Pressure Test

For GT, ST&Shunt Reactor tank of each type shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 kN /m² whichever is lower, measured at the base of the



tank and maintained for eight hours. The permanent deflection of the plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

For auxiliary transformers & Neutral Grounding Reactor each type of tank shall be subjected to the vacuum & pressure tests as per CBIP norms.

(b) Type tests

For UT and Auxiliary Transformers Vacuum and Pressure tests shall be type tests. Pressure and Vacuum tests shall be carried out as per procedure mentioned in the above Tank tests-routine test clause for GT, ST and Reactors. However, Pressure test shall be conducted for one hour duration only.

1.11.06

NEUTRAL GROUNDING RESISTANCE (NGR) TESTING

(a.) The following routine tests shall be conducted on each resistor provided with transformer covered in this section.

(1.) Ohmic value measurement (For resistance & reactance separately).

(2.) Insulation resistance measurement before & after HV test

(3.) HV test for 1 min. at a voltage corresponding to the insulation level of the resistor.

(b.) DOP test on enclosure (routine test): It shall not be possible to insert a 2.5mm dia steel wire into the enclosure from any direction without using force.

(c.) Short time current test along with temperature rise test (type test).

(d.) Degree of protection test for IPX3 on enclosure (type test).

1.12.00

Commissioning Checks

Apart from general & prescribed commissioning checks following additional checks shall also be performed on GT, ST, UT & Shunt Reactor:-

1. FRA Test

2. Core isolation test

3. DGA test

1.13.00

Initial Operation for Transformers

a) Continuously observe the transformer operation at no load for 24 hrs. w.r.t. Voltage, no load current, temperature rise and noise.

b) 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.

c) For GT, ST & UT Infrared thermography shall be done after 12 hours of full load operation and results will be recorded for future reference.

1.14.00**Installation and movement of spare GT on site**

The spare transformer shall be erected and prepared for long term storage as well as for the rapid transfer of this unit into a service position as approved by the Owner.

1.15.00**TRANSPORTATION**

The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. All metal blanking plates and covers which are specifically required to transport the transformer shall be considered part of the transformer and handed over to SCCL after completion of the erection. The total duration of storage at site with dry gas shall be limited to three(03) months after which transformer/reactor shall be processed and filled with oil.

The scope of any necessary modification/ extension/ improvement to existing road, bridges, culverts etc. shall be included in the scope of the bidder.

NOTE:

Despite all condition monitoring done by the Owner, the Contractor shall be responsible to obtain all required inputs such as DGA to evaluate the Transformer/Reactor. The guarantee and costs of any repair done under the guarantee shall not be affected by any condition monitoring done or not done by the Owner during the guarantee period. A full DGA test shall be completed at the end but before expiry of the guarantee period.

2.00.00**DRY TYPE TRANSFORMER (LT INDOOR)(AUXILIARY TRANSFORMER)**

Sr. No.	PARAMETERS	INDOOR TRANSFORMER
i)	Type	Epoxy cast Resin. All windings shall be Epoxy Resin casted.
ii)	Service	INDOOR
iii)	MVA & Voltage ratio	As per system requirement/ Sub section B-0
iv)	Vector group	
v)	Impedance	
vi)	Tap changer type & range	
vii)	SC withstand time & Fault Level	
viii)	Termination	
ix)	Number of phases	Three (3)
x)	Type of cooling	AN Additionally Transformer shall be provided with fans/blowers(total fan power min. 1350 W, 415 V)for forced air cooling however all tests and performance guarantee shall correspond to air natural (AN) cooling.
xi)	Duty	Continuous
xii)	Insulation level	As per chapter B-0, Part-B

xiii)	Maximum Temperature rise of winding over 50 deg. C ambient. (by resistance method) with Air Natural (AN) cooling.	70deg.C.
xiv)	Earthing	Solidly earthed via cu flat.
xv)	Noise Level	Not to exceed values specified in NEMA TR-1.
xvi)	PD Level for HV coil (max.)	20 pc
xvii)	Loading Capability	Continuous operation at rated KVA on any tap with voltage variation of +/-10% corresponding to the voltage of the tap as well as in accordance with IEC60076-7/IS: 6600.
xviii)	Flux Density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds.

Note:- LT Indoor transformers shall be 3 phase, 4 wire system with additional LVN Bushing for equipment earthing.

2.01.00
CODES AND STANDARDS

Dry type transformers	IS: 11171, IEC 60076-11
Indian Electricity Act 2003 and Indian Electricity Rules, BEE notification & CEA guidelines	

2.02.00
DESIGN AND CONSTRUCTIONAL FEATURES

- 2.02.01 The core shall be constructed from high grade non-ageing cold rolled grain oriented silicon steel laminations of M4 grade or better quality. The insulation of core to clamp-plates shall be able to withstand a power frequency voltage of 2 kV (rms) for one (1) minute.
- 2.02.02 The transformers shall be housed in a metal protective housing, having a degree of protection of IP-23. Enclosure shall be of a tested quality sheet steel of minimum thickness 2mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting. Suitable bi-directional skids with pre-drilled holes shall be provided integral with the enclosure or bi-directional rollers shall be provided with suitable locking arrangement.
- 2.02.03 Winding conductor shall be electrolytic grade Copper. Windings shall be of class F insulation. All windings are to be uniformly insulated.
- 2.02.04 Transformer HV bushings and LV bushings can be either solid porcelain or epoxy type. Bushing shall be suitable for satisfactory operation in the high ambient temperature inside Bus Duct enclosure (if applicable). LV flange area shall be of non-magnetic material.
- 2.02.05 Bushing CTs shall be provided in the LV neutral side of adequate rating for REF protection, WTI, etc.



CLAUSE NO.

TECHNICAL REQUIREMENTS

2.02.06 For Marshalling Box the sheet steel used shall be at least 1.6 mm thick cold rolled. The box shall be tank mounted type. The degree of protection shall be IP-54 in accordance with IS-13947. Wiring Scheme shall be engraved in a stainless steel plate with viewable font size and the same shall be fixed inside the Marshalling Box door.

2.02.07 Transformer shall be provided with fans/blowers (with 100 % standby) for forced air cooling, however all tests and performance shall correspond to air natural cooling. Necessary wiring arrangement for fans auto and manual start shall be provided.

2.03.00 PAINTING

The inside of enclosure and accessories (except M. Box) shall be painted with two coats of fully glossy white colour with total DFT of 25 to 60 microns. The external paint colour of transformer & accessories shall be blue corresponding to RAL 5012. The external surface of transformer & accessories shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of polyurethane finish paint with total DFT of 80 to 150 microns. The internal surface of M.Box shall have two coats of chemical resistant epoxy zinc phosphate primer and two coats of chemical & thermal resistant epoxy enamel white paint with total DFT of 80 to 150 microns.

2.04.00 FITTING

Winding temperature indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb. Single Indicating meter may be provided for display of temperature of all limbs. Accuracy class of Indicating meter shall be +/- 1% or better and it shall have least count of 0.1 °C or better. 1 no. 4-20 mA signal shall be provided for remote monitoring of winding Temperature. Blowers (AF cooling) shall have Manual and Auto control (with WTI user programmable temperature).
RTD/Thermistors	1 No. PT-RTD shall be embedded in each limb with alarm and trip contacts for remote annunciation. Additional 1 No. thermistor/RTD shall be embedded in each limb.
Fittings which are generally required for satisfactory operation of the transformers are deemed to be included, in the scope of supply of the Contractor.	

2.05.00 TESTING REQUIREMENTS

2.05.01 The Type Test reports which have to be submitted should be of a transformer which is generally similar to the transformer being offered as per IEC 76-5, Annexure-B and also identical to the offered transformer in following aspects:

- i) Voltage ratio
- ii) MVA/KVA rating
- iii) Percentage Impedance
- iv) Internal design
- v) Type of tap changer equipment
- vi) Cooling arrangement
- vii) Temperature rise

viii) Individual and total loss values of the offered transformer shall be same as that indicated in the GTP of transformer for which Type Test Reports are submitted

2.05.02 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

2.05.03 All routine tests in accordance with IS: 2026 part-11 shall be carried out on each transformer.



2.05.04

Transformer shall be short circuit tested after conducting the routine tests. Rest of the type tests shall be conducted after successful short circuit testing.

Routine / Type Tests (Dry Type Transformers)		
a.)	Measurement of winding Resistance for each tap position.	Routine Test
b.)	Measurement of voltage ratio at each taps position.	Routine Test
c.)	Vector group and polarity check	Routine Test
d.)	Measurement of impedance voltage/short circuit impedance & load loss at principal tap and extreme taps	Routine Test
e.)	Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.	Routine Test
f.)	Measurement of insulation resistance	Routine Test
g.)	Measurement of capacitance and tan delta	Routine Test
h.)	Dielectric Tests	
	1) PF/Separate source AC withstand voltage test.	Routine Test
	2) Chopped wave lightning impulse voltage test on all the three limbs as per IEC 60076-3	Type Test
	3) Induced over voltage withstand test	Routine Test
i.)	Partial discharge measurement (However if it is conducted as routine test on all the coils, this test can be performed as type test).	Routine Test
j.)	Measurement of iron loss & IR (repeat after induced voltage test)	Routine Test
k.)	Short Circuit test as per IEC	Type Test
l.)	Noise Level Measurement	Type Test
o.)	Temperature rise test as per IEC (HV & LV winding)	Type Test

2.05.05

High voltage withstand test shall be performed on auxiliary equipment and wiring after assembly.

3.00.00

MAINTENANCE, TESTING & MONITORING EQUIPMENTS

1.	On Line DGA	Online monitoring system of dissolved gases for GTs	3 Nos.
2.	Oil BDV Measurement kit.	Automatic oil testing unit for checking BDV of transformer oil upto 80kV.	1 No.
3.	Oil tan delta and resistivity measurement kit.	Suitable for measurement of Volume resistivity, Dielectric constant, Watt loss, loss factor with elevated temperature read out for transformer oil.	Not Required
4.	Dew point meas. instrument.		Not Required
5.	FRA Test Kit		1 No.
6.	Capacitance& Tan delta meas. Equip. (with cables etc.)- Shall be suitable for	0-10kV (Fully Automatic)	Not Required



CLAUSE NO.

TECHNICAL REQUIREMENTS

	generator application also		
7.	Transformers turns ratio Kit	Display of ratio & phase angle deviation.	1 No.
8.	Winding Resistance measurement kit		1 No.
9.	Off Line laboratory model oil DGA kit.		1 No.
10.	Hydraulic jacking system	Suitable for lifting / wheel rotation for heaviest oil filled Transformer/Shunt Reactor.	1 No.
11.	On Line Moisture Removal System	(One for each 3 phase GT Bank)	1 Set
12.	Oil Purifying Equipment	10,000 Litres / hr.	1 No.
13.	Oil Purifying Equipment	1,000 Litres / hr.	Not Required
14.	Vacuum pump with motor, pipes & accessories	Free air displacement of 3040L/min, Ultimate pressure of 0.7PA & Blank off vacuum of 0.01torr.	1 No.
15.	Oil tanker, wheel mounted, 10kL capacity	10kL Capacity	Not Required.
16.	Oil tanker, wheel mounted, 5kL capacity	5kL Capacity	Not Required.
17.	Dielectric Response Analyzer		1 No.

3.01.00 ON-LINE DISSOLVED GAS ANALYSER (DGA) SYSTEM

Each Generator Transformer shall be fitted with on-line DGA equipment. The terminals shall be wired up to the M. Box/CMB/CMS to enable remote alarm/trip and status information. The On line DGA monitoring equipment shall be able to monitor H₂, CO, C₂H₄ & C₂H₂.

3.01.01 Technical parameters

The system shall meet the following technical parameters:

a) Detection & measurement of gases	H ₂ , CO, C ₂ H ₄ & C ₂ H ₂ with 100% sensitivity to H ₂ & C ₂ H ₂
b) Accuracy (maximum)	H ₂ : ±10% or ± 5 ppm (whichever is greater) CO: ±10% or ± 10 ppm (whichever is greater) C ₂ H ₄ : ±10% or ± 3 ppm (whichever is greater)

	C2H2: $\pm 10\%$ or ± 1 ppm (whichever is greater)
c) Oil temperature range of sensor	10°C to 100°C
d) Sensor attachment degree of protection	Minimum IP55
e) Minimum detection sensitivity to C2H2	2 ppm

3.01.02

General technical requirements of DGA

- a) The system offered shall be suitable for online monitoring of dissolved gases in oil filled (Napthanic / Paraffanic based oil) power transformer. It shall atleast measure dissolved gases such as H₂, CO, C₂H₄ & C₂H₂ with 100% sensitivity to H₂ & C₂H₂.
- b) The system shall be suitably be fitted to transformer in accessible location to be decided by contractor with employer's approval. Contractor shall provide necessary adopter /fittings for this purpose. The attachment shall be provided with oil sampling port to facilitate oil collection for manual off-line DGA by owner. All software/hardware/cables/PC for monitoring from control room shall be in the scope of the contractor. The supplier shall also provide a suitable calibrating arrangement for each online DGA. The software for remote monitoring in control room shall facilitate real time data logging & also historical data/trend display.
- c) Potential free alarm contacts for high gas concentration (user programmable) of each gas shall be wired upto transformer M. Box/CMB. These will be used for facia alarm in control room and DDCMIS/SCADA. Also real time data for concentration of each gas shall be provided at SAS control room through SAS with NTPC required format & communication. All required cable, software, hardware & cable laying for the above communication shall be in the scope of contractor.
- d) Installation and cable connection drawing shall be furnished for approval.
- e) System shall be suitable for operation at 50 degree centigrade ambient temperature & 85% relative humidity.
- f) Spare Generator Transformer shall have suitable provisions to be hooked up with online DGA system as and when required.

3.02.00

ON LINE MOISTURE REMOVAL SYSTEM

One phase of the Generator transformer shall be equipped with "Online Moisture Removal System". However other phases including spare GT shall have suitable provision so as to provide same at a later stage. The system shall be fitted in an enclosure. Oil Moisture measurement probe shall be provided with "Online Moisture Removal System". Alarm / status information shall be appropriately wired upto the Common M. box through for monitoring in SAS.

3.03.00

FREQUENCY RESPONSE ANALYSER

3.03.01

TECHNICAL PARAMETERS

a)	Test Method	:	Sweep Frequency Response Analysis
b)	Frequency Range	:	10 Hz to 10 MHz
c)	Provision of selection of user defined frequency range within above frequency range.		
d)	Accuracy	:	(+ /-) 1 dB
e)	Operating Voltage	:	230 V, 50 Hz
f)	Built in self-calibration.		

g)	Equipment shall be able to display and plot frequency Vs magnitude and frequency Vs phase angle curves.
h)	Equipment shall be complete in all respect with all-necessary cables, printer, Floppy/CD drive etc.
i)	Suitable for use at 50 deg.C ambient temperature & 85% relative humidity.
j)	The instruments & cable shall be designed to ensure repeatable measurement confirming to relevant international standard.

3.03.02 GENERAL TECHNICAL REQUIREMENT FOR FRA

Employer intends to do condition assessment of transformers using the frequency response technique. The equipment should broadly consist of variable frequency voltage source, network analyzer, necessary software and cabling, Equipment shall be portable and shall be capable of onsite use.

3.04.00 HYDRAULIC JACKING SYSTEM

This shall be minimum four jack systems having motor operated synchronous operation suitable for lifting/wheel rotation of heaviest Oil filled power transformers & Shunt reactor in this package. System shall be complete in terms of piping, hydraulic system and associated auxiliaries.

3.05.00 CAPACITANCE & TAN DELTA MEASURING EQUIPMENT

3.05.01 NA

3.06.00 HIGH VACUUM TYPE OIL PURIFYING EQUIPMENT
3.06.01 TECHNICAL PARAMETERS

a) Capacity	10,000 litres/hr.
b) Type	Weather proof mobile and outdoor type high vacuum oil filtration plant.
c) Processing temperature (direct heating of oil prohibited)	60 °C (max.)
d) Capability of plant on a single pass basis	
i) Removal of moisture	From 100 ppm to 3 ppm
ii) Removal of dissolved gas content	From 10% by vol. to 0.1% by Vol.
iii) Improvement of dielectric strength	From 20 kV to 70 kV
e) Filtration pore diameter	0.5 microns or less
f) Vacuum pumping system	Two independent vacuum pumping combination, one for degassing chamber and other for transformer oil evacuation and creating high vacuum in tank. The blank off vacuum of each pumping system shall be 10^{-3} torr or less.
g) Operating voltage	440/400 Volt, 50 Hz, 3 phase, 4 wire supply.

3.07.00 OIL TAN DELTA AND RESISTIVITY MEASUREMENT KIT

Not Required



3.08.00

OIL BDV MEASUREMENT KIT

- a) Automatic oil testing unit for checking BDV of Transformer oil up to 80kV.
- b) The kit should be suitable for laboratory use.
- c) The kit should be fully automatic with sequence control.
- d) Separate voltmeter for calibration of kit should be supplied.
- e) The results should be stored in memory for subsequent retrieval.
- f) Separate printer should be available for printing test results.
- g) The kit should be able to test oil as per BS5730, IEC156, ASTM test standard.
- h) Basic accuracy desirable is 3%.

3.09.00

TRANSFORMER TURNS RATIO (TTR) MEASUREMENT KIT

- a) Microprocessor controlled fully automatic test set.
- b) Automatic measurement and digital display of ratio, phase angle deviation.
- c) Automatic polarity indication.
- d) Light weight and portable.
- e) Three-phase ratio and excitation current meter.
- f) Automatic data storage of tests and reports generation.

3.10.00

VACUUM PUMP WITH MOTOR, PIPES & ACCESSORIES FOR EVACUATING VACCUM IN TRANSFORMER

3.10.01

Technical Parameters

- a) Free air displacement: Minimum 3000 L/min,
- b) Ultimate pressure : 0.7PA
- c) Blank off vacuum : 0.01 torr

3.11.00

DEW POINT MEASUREMENT INSTRUMENT

Not Required

3.12.00

WINDING RESISTANCE MEASUREMENT KIT

1. Microprocessor controlled fully automatic operation.
2. Wide range of test current(minimum current of 50A).
3. Suitable for operation in EHV Switchyard condition.
4. Protection circuit for suppression of induced voltage kickback.
5. Display of resistance vs time curve.
6. Computer and printer interface.
7. Lightweight and portable.
8. The kit should safely dissipate the energy stored in the transformer after test.

3.13.00

OFF LINE LABORATORY MODEL OIL DGA KIT

3.13.01

Power supply : 240 V $\pm 15\%$, 50Hz $\pm 5\%$, AC, Single Phase

3.13.02

Compatibility : IEC-60567/ASTM D 3612 Method-C (with auto-sampler)

3.13.03

Main Frame : Complete with gas extraction, injection port; column, oven, TCD-Detector, gas flow regulation, measurement system & related electronics, PC with latest configuration, Color Monitor, Printer.

(e.) Injection System:

Dual column injection system with provision for introducing sample range from 1 to 5 ml. The sample volume must be reproducible such that successive runs agree within 1 mm or 1% (which ever is larger) on each component peak height.

(f.) Injection Temp:

50°C to 400°C in 1 °C increment.

(g.) Drier :

Ahead of sample inlet to remove complete moisture with removal of components.

(h.) Oven :

Should have sufficient space to house the analytical columns & reference columns. The oven shall be equipped with precise temperature control and measurement system to maintain the columns within $\pm 1^\circ\text{C}$ of the specified temperatures even during temperature programmed runs. The oven should be capable of maintaining temperatures 10°C above ambient to 400°C .

It should have also the following features:

(i.) Column over heat protection: user can set up to 400°C .

(j.) Temperature Programmer: Rate from 1°C to $45^\circ\text{C}/\text{min}$. 3 ramps with initial and final holds.

(k.) Automatic cooling under process control.

(l.) 6 port valve: A six way flanged PTFE of equivalent plug to permit the use of either the absorption or partition column and for reversing the carrier flow and another six port valve for gas sampling.

Note: Any other valve configuration depending upon the types of columns configuration offered may also be supplied.

(m.) Columns :

10 ft x 1/8"	Poropak N (80/100 mesh)
3 ft x 1/8"	Molecular sieve 13 x (45/60 mesh)

(n.) Detection Limits

H2	10 PPM
C2H4, C2H6, C2H2, C3's	1 PPM
CO2, CO	25 PPM

Note: Any other column configuration suitable for the complete analysis of the transformer oil may be supplied.

(o.) Detector: Thermal conductivity detector or equivalent in range, sensitivity and stability.

(p.) TCD : It should have the following features :

- (1.) Operating temp. : 100°C to 350°C in 1°C increment.
- (2.) Linearity: above 105 range

(q.) Carrier gas flow system: The equipment shall be equipped with EPC to provide a flow of carrier gas through columns at a flow that is constant to 1% throughout even during temperature programming.

(r.) Auto Sampler: System shall be able to extract gas automatically and transfer to GC unit.

3.13.04

The equipment shall be equipped with dual flow, dual column system. The inlet pressure and flow rate of the carrier gas should be controlled by electro pneumatic control as well as through data processor with digital and screen display of the pressure and the flow rates.



CLAUSE NO.

TECHNICAL REQUIREMENTS

3.13.05 Equipment should have provision of operation with PC (with latest configuration) with Interface IEEE 488-GPIB or RS 232 c Serial Interface of LAN card. The computer should be with latest configuration having Deskjet Colour Printer with IFT Colour Monitor.

3.13.06 Software : The system should have the current windows based software with function of calibration, recalibration, Data storage, re-slope, display of recommended condition.

3.13.07 Accessories: All other accessories required for independent operation of the equipment.
i. Operation Manual
ii. Service Manual
iii. For routine maintenance of the equipment other requirements :
- The equipment must be installed/commissioned and also demonstrated for all features specified by the supplier/their authorized agent.

3.13.08 1 no. of oil sampling vessel shall be provided.

3.13.09 Certified Calibration gas standard(for calibration of gas Chromatograph)

Composition:	
H2	100 PPM
CH4	100 PPM
CO	100 PPM
CO2	1000 PPM
Ethylene	100 PPM
Ethane	100 PPM
Acetylene	10 PPM
Propane	100 PPM
Propylene	100 PPM
To be supplied in 3 liter water capacity carbon steel or aluminum cylinder filling pressure:	120 Kg/Cm ² (approximately) or 0.5 liters aluminium container, 20 Kg/Cm ²
Stability	The standard supplied should have at least 1 Year stability
Certificate	The standard should carry a certificate which is should be traceable to NIST standard.
Preparation Tolerance	±20%
Certification Accuracy	±2%

3.14.00 NA

3.15.00 DIELECTRIC RESPONSE ANALYZER

The equipment shall be used for measurement and analysis of water (moisture) content in oil-paper insulations of power transformers, CT's and OIP bushings by Dielectric response principles and shall have following features:

3.15.01 The test equipment shall use Frequency Domain Spectroscopy (FDS) or combination of Frequency Domain Spectroscopy and polarization depolarization Current (PDC) analysis techniques. If the equipment uses combination of FDS & PDC methods, the change-over from FDS to PDC method or vice versa shall be automatically done by the software. It shall also be possible to make measurements, if required, in UST, GST & GSTg modes.

3.15.02 The software for operation of the kit and analysis of the results shall be provided. The software shall be user friendly. The software shall have in-built test templates for testing of transformers (Two winding/Three winding /Auto transformers) and shall display the connection diagram accordingly for ease of operation. The analysis software should have model curves with known water content for comparison of curves. The software shall provide an automated procedure for assessing the moisture content of the cellulose

(pressboard and paper) of the power transformer insulation in percentage (%).

3.15.03 The test results shall not be influenced by interferences in 400kV live switchyard.

3.15.04 The test set should be supplied completely with test kit, leads, laptop, necessary software and hard transport case.

3.15.05 Technical Specifications:

Frequency	0.1 mHz - 5 kHz
Voltage/Current Output (peak)	0-200V, 0-50mA
Capacitance Range	10 pF to 100 μ F
Dissipation Factor Range	0-10



SUB-SECTION-B – 05A

MV SWGR (SWITCHGEAR)

CODES AND STANDARDS

a)	IS: 722	AC electricity meters.
b)	IS: 996	Single phase small AC and universal electrical motors.
c)	IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories.
d)	IS/IEC: 60947	Degree of protection provided by enclosures for low voltage switchgear and control gear.
e)	IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.
f)	IS: 2705	Current transformers.
g)	IS: 3156	Voltage Transformers
h)	IS: 6005	Code of practice for phosphating of iron and steel.
i)	IS: 3427	Metal enclosed switchgear and control gear
j)	IS: 5082	Specification for wrought aluminum and aluminum alloy bars, rods, tubes and selections for electrical purposes.
k)	IEC: 61850	Communication Standard for Numerical relays
l)	IEC: 61131-3	Automation Standard for Numerical relays
m)	IS: 9046	AC contactors for voltages above 1000 volts and upto and including 11000 Volts.
n)	IS: 13703	Low voltage fuses
o)	IS: 9385	HV fuses
p)	IS: 9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV
q)	IS: 9921	A.C. disconnectors (isolators) and Earthing switches for voltages above 1000 V
r)	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
s)	IS: 13118	Specification for high voltage AC circuit breakers.
t)	IEC: 60099-4	Metal oxide surge arrestor without gap for AC system
u)	IEC: 62271-100	High voltage alternating current circuit breakers.
v)	IS/IEC: 62271-200	High voltage metal enclosed switchgear and control gear.
w)	IEC: 60947-7-1	Terminal blocks for copper conductors
x)	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips
y)	IS:15652	Specification for Insulating mats for electrical purposes

TECHNICAL PARAMETERS

a) SYSTEM PARAMETERS			
1	Nominal System voltage	11 kV	3.3 kV
2	Highest System voltage	12 kV	3.6 kV

CLAUSE NO.	TECHNICAL REQUIREMENTS					
	3	Rated Frequency	50 Hz	50 Hz		
	4	Number of phases/ poles	Three	Three		
	5	System neutral earthing	Earthed through Resistance to limit fault current to 600 A			
	6	One minute power frequency withstand voltage				
		- for Type tests	28	10		
		- for Routine tests	28	10		
	7	1.2/50 microsecond Impulse withstand voltage	75 kV (peak)	40 kV(peak)		
	8	Maximum system fault level including initial motor contribution	50 kA (rms)	40 kA (rms)		
	9	Short time rating for bus bars, ckt. breakers, current transformers and swgr. Assembly.	50 kA (rms) for one (1) sec.	40 kA (rms) for one (1) sec.		
	10	Dynamic withstand rating	125 kA (peak)	100 kA (peak)		
	11	IAC Rating	40 kA, 1 sec (As per IEC 62271-200)			
	12	Maximum ambient air temperature	50 deg. C	50 deg. C		
	b) BUS BARS					
	1.	Continuous current rating at 50°C ambient:	As Per System requirements			
	2.	Material	High Conductivity Al/Copper			
	2.	Temper Rise allowed above ambient	40°C for plain joints 55°C for Silver plated joints			
	3.	Sleeves	Non-Halogen Based Heat Shrinkable polyolefinic sleeves			
	c) SWGR. CUBICLE CONSTRUCTIONAL REQUIREMENTS					
	1.	Cable entry				
		a)	Power Cables	Bottom		
		b)	Control Cables	Bottom		
	2.	Busduct entry	Top			
	3.	Earthing conductor	Galvanized steel strip			
	4.	Service Continuity of swgrs(as per IS/IEC 62271-200)	LSC2B-PM			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
	5.	Degree of Protection	IP 5X for relay compartment, IP4X for remaining compartment		
	6.	Material	Enclosure: Rolled steel/Alu Zinc Door/covers:2mm CRCA Gland Plate:2.5mm (Hot/cold Rolled steel), 3mm(non magnetic)		
	7.	Type of cooling	Natural air flow up to 3000A Forced cooling above 3000A		
	8.	Safety Shutter	As per IEC 62271-200		
	d) CIRCUIT BREAKERS				
	1.	The circuit breakers current rating shall be selected from the load current given in SLD which is at an ambient of 50° C.			
	2	Type	Vacuum type Anti pumping Electrical & Mechanical		
	3.	Short circuit breaker	11 kV	3.3 kV	
		Current			
		a) A.C. component	50 kA	40 kA	
		b) D.C. component	As per IS: 13118 or IEC-62271		
	4.	Short Circuit making current	125 kA (peak)	100 kA (peak)	
	5.	Operating Duty	O-3min-CO-3min-CO		
	6.	Total break time	Not more than 4 cycles		
	7.	Total make time	Not more than 5 cycles		
	8.	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271		
	9.	Control supply voltage	Closing coil/spring charging motor 220/110 V DC (-15/+10%) Tripping coil 220/110 V DC(-30/+10%)		
	e) CURRENT TRANSFORMER				
	1.	Secondary Current	1A		
	2.	Class of Insulation	Class E or better		
	3.	Rated output	Adequate for the relays and devices connected, but not less than five (5) VA.		
	4.	Accuracy class			
		Protection	Class PS for differential, REF and Core Balance CTs (CBCT); 5P20 for other protection CTs		
		Measurement	0.2s for Station & Unit Incomers and any other defined feeders as marked in SLD.		
	5.	Minimum primary earth fault current to be detected by CBCT	3 Amperes		
6	CBCT	50/1 A, Single, circular window type CBCT for each outgoing motor and transformer feeder			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
	6.	Instrument Security Factor for Measurement CTs	5		
	f) VOLTAGE TRANSFORMERS				
	1.	Rated Voltage Factor	1.2 continuous for all VTs, and 1.9 for 30 seconds for star connected VTs.		
	2.	Class of insulation	Class E or better		
	3.	Other parameters	BUS PT-0.5 Class,VA req. adequate for application. Line PT-0.5 Class for sync./3P for door interlocks, VA req. adequate for application.		
	g) H.V. FUSES				
	1.	Voltage class	3.3kV		
	2.	Rupturing Capacity	Adequate for 100 kA (peak)		
	3.	Rated current	As per application		
	h) SURGE ARRESTERS (FOR MOTOR FEEDERS)				
			11 kV	3.3kV	
	1.	Nominal discharge Current (8x20 μs)	5kA	5kA	
	2.	Continuous Operating Voltage	12 kV	4.5 kV	
	3.	Max allowable Residual voltage at nominal discharge current	40 kV	15kV	
	4.	Mounting	Inside panel	Inside panel	
	i) CONTACTORS :				
	1.	Nominal System Voltage	3.3kV		
	2.	Highest System Voltage	3.6kV		
	3.	Rated Frequency	50 HZ		
	4.	Rated Continuous Current at 50°C ambient	Current rating shall be selected appropriate for the load current		
	5.	Control Supply Voltage	240V DC / 120V DC unearthed		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
3.00.00	6.	Utilisation category	AC-3
	7.	Type	Vacuum, HRC fuse backed mechanically latch type contactor for conveyor & crusher motor feeder panel(CC)
	8.	Control Supply Voltage	Closing Coil 220/110 V DC (-15/+10%) Trip Coil 220/110V DC(-30/+10%)
	j) Earthing and Earthing devices		
	1.	Material	Copper/Galvanized steel with adequate cross-section to carry the momentary short circuit fault current to Earth
	2	Earthing Truck or mechanism	Bus/ Line side earthing truck or mechanism of each type rating & size to be provided at individual switchgear room
	k) Control terminal blocks		
	1.	Rating	650V grade, 10 A ,6.6 polyamide UL 94
	2.	Type	Screw less, push in technology (IEC 60947-7-1 and UL certified)
	l) Switchgear Wiring		
	1.	Rating & size	650 V grade, single core 2.5 sq. mm cu for CT connection 1.5 sq. mm cu for others
	m)	Insulating Mat	As per IS 15652
	GENERAL TECHNICAL REQUIREMENTS (a) The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free-standing floor mounted panels. (b) Suitable trolley shall be provided by the Contractor for withdrawal and insertion of the breaker truck from and into the (in case of truck roll out on telescopic rails) (c) Circuit Breaker/Contactor rack-in and rack-out from Service to Test, Test to Isolated position, or vice-versa shall be possible only in the compartment door closed condition and compartment door shall not open while circuit breaker/contactors is in Service position. (d) All insulating components being used in panel shall be Flame Retardant as per UL-94 V0 flammability standard. (e) Suitable base frames made from steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates as per approved installation drawings shall be in Contractor's scope. (f) The switchboard shall have the facility of extension on both sides. Adopter panels and dummy panels required to meet the various busbar arrangements, cable / busduct termination and layouts shall be included in Contractor's scope of work. (g) <u>Rear Cover Safety Interlock Requirements:</u> i. Busbar compartment cover of any panel can be opened only if the incomer/tie /bus-coupler (i.e. incoming sources) are in isolated position and busbar is in de-energized condition. Inversely, incomer/tie /bus-coupler coupler (i.e. incoming sources) can be closed only if all the Busbar compartment covers are closed. ii. Cable/Bus-duct compartment cover (Line Side) of Incomer/Tie can only be opened while upstream (source) breaker is in isolated position and line is dead. Inversely, upstream(source) breaker can be closed only if Cable/Bus-duct compartment cover (line side) of downstream side Incomer/Tie panel is closed.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 																						
	iii. The cable compartment cover of any panel can be opened only when circuit breaker of that panel is in isolated position. Inversely, the circuit breaker can be closed only if subject cable compartment cover is closed. iv. LED must be mounted on the rear side of panel indicating "RED" while breaker is on and in-service condition. (h) Wireless temperature monitoring system to be provided and same shall be integrated to DDCMIS/ separate HMI. Temperature sensors shall be installed in all relevant joints, contact joints etc. as per the standard OEM Practice, however Position of such sensors shall be decided at the time of detailed engineering. (i) For EPB circuit(2NO+2NC) in HT drives, one set (1 NO+1NC) contact shall be directly connected in breaker tripping circuit and other set shall be routed through interface relay to DCS. Separate cables and glands shall be provided for 2 different set of contacts. 4.00.00 PROTOTYPE PANELS In order to establish the compliance with the requirements of this technical specification, prototype panels of each module type shall be made and offered for the Employer's inspection and approval before the start of bulk manufacturing of panels for this project. 5.00.0 TESTS 5.1.00 Type tests <table border="1" style="margin-left: 20px; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: center;">a)</td><td>The following type test reports on circuit breaker / circuit breaker panels, of each voltage class and current rating shall be submitted</td></tr> <tr> <td style="text-align: center;">1)</td><td>Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs, bushing and separators.</td></tr> <tr> <td style="text-align: center;">2)</td><td>Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.</td></tr> <tr> <td style="text-align: center;">3)</td><td>Power frequency withstand test on breaker mounted in side panel.</td></tr> <tr> <td style="text-align: center;">4)</td><td>Lightning impulse withstand test on breaker mounted in side panel.</td></tr> <tr> <td style="text-align: center;">5)</td><td>Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the centre.</td></tr> <tr> <td></td><td>The adjacent panels shall also be loaded to their rated current capacity. Alternatively the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration</td></tr> <tr> <td style="text-align: center;">6)</td><td>Internal Arc Test as per IEC 62271-200</td></tr> <tr> <td style="text-align: center;">7)</td><td>Measurement of resistance of main circuit.</td></tr> <tr> <td style="text-align: center;">8)</td><td>Mechanical operation test.</td></tr> <tr> <td style="text-align: center;">9)</td><td>Degree of protection</td></tr> </table>	a)	The following type test reports on circuit breaker / circuit breaker panels, of each voltage class and current rating shall be submitted	1)	Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs, bushing and separators.	2)	Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.	3)	Power frequency withstand test on breaker mounted in side panel.	4)	Lightning impulse withstand test on breaker mounted in side panel.	5)	Temperature rise test on breaker and panel together. For this test, the test set up shall include three panels with breakers, the test breaker and panel being placed in the centre.		The adjacent panels shall also be loaded to their rated current capacity. Alternatively the test panel may be suitably insulated at the sides, which will be adjoining to other panels in actual site configuration	6)	Internal Arc Test as per IEC 62271-200	7)	Measurement of resistance of main circuit.	8)	Mechanical operation test.	9)	Degree of protection
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	b)	The following type tests reports on Contactor and Contactor panels of each type and rating shall be submitted.		
	1)	Verification of rated making and breaking capacities of the contactor.		
	2)	Short time withstand test of panel.		
	3)	Power frequency test on the contactor mounted in side panel.		
	4)	Lightning impulse voltage withstand test of the contactor mounted in side panel.		
	5)	Measurement of resistance of main circuit.		
	6)	Test to confirm coordination between fuse and contactor.		
	c)	Short circuit withstand test of earthing device (truck / switch).		
5.2.00	Routine Tests All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. The manufacturer shall furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. Testing to observe compliance to degree of protection, shall be checked for each switch board enclosure and busbar chambers during routine inspection shall be as under. (a.) IP -4X It shall not be possible to insert a one (1) mm. dia steel wire into the enclosure from any direction, without using force. (b.) IP-5X It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.			
5.3.00	COMMISSIONING CHECKS / TESTS Bidder shall submit commissioning test procedure including details of all commissioning check before commissioning the system at site Note:- This chapter has to be read in conjunction with sub-section B-0"general electrical specification" of Technical specification Section-VI, Part-B and Sub-Section IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A and Part-E.			
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159-C-O-M-001	SUB SECTION B-05(A) MVSWITCHGEAR	PAGE 7 OF 7



SUB-SECTION-B – 05B

MV SWGR (PCM)

CLAUSE NO.	TECHNICAL REQUIREMENT			
	PROTECTIONS, CONTROL AND METERING			
1.00.00	SYSTEM DESCRIPTION			
1.01.00	SWITCHGEAR NUMERICAL RELAY NETWORKING			
	Switchgear Numerical Relay network Architecture			
	(a) The typical configuration of such a proposed system is as per the enclosed drawing no. 0000-205-POE-A-001 (Overall Architecture of Switchgear Relay Network). The numerical relay network shall include relays on all MV & LV switchgears being supplied under this package. Each ring network shall consist of switchgear level Ethernet switches connected through Fibre Optic cable and subsequently connected to Network Level Ethernet Switches placed in main plant control equipment room (CER).			
	(b) The point-to-point testing of all signals of Numerical Relays for the Switchgear network at the DDCMIS and protection equipment(Switchgear) end shall be the responsibility of the contractor.			
2.00.00	SYSTEM PERFORMANCE REQUIREMENTS			
2.01.00	Latency: The system shall be so designed and implemented as to provide data transfer speeds prescribed by IEC 61850-5.			
2.02.00	Reliability: All components shall be designed and configured to make the system highly reliable. Failure of any component shall be immediately announced and wherever possible, the system shall be made self-healing.			
2.03.00	Diagnostic tools: The system shall have necessary diagnostic tools to continuously monitor the system performance and provide feedback to the operator / engineer. Necessary software tools to track changes in the system shall be provided.			
3.00.00	NUMERICAL RELAYS			
3.01.00	General requirements			
3.01.01	All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity for the intended application.			
3.01.02	All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and preferably shall be more than 70% of the rated control supply voltage.			
3.01.03	One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).			
3.01.04	All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts, the quantity of which shall be adequate to realize the associated interlocks / feedbacks. At least 2 binary inputs (BI)&2 binary outputs (BO) shall be kept as Spares for Employer's future use.			
	In case the offered IED does not have the required number of I/Os,the same can be achieved through external I/O device of same make complying with the requirement.			
3.01.05	Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker			
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB SECTION B-05(B) MV& LV SWGR- PROTECTIONS, CONTROL & METERING	PAGE 1 OF 10
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CLAUSE NO.	TECHNICAL REQUIREMENT		
3.02.00	Protections: Relay Types & Protections		
3.02.01	Motor Feeder Protections (Module Type DA/DAF/CC/DM) The Motor protection relay shall be suitable for providing the following protections a) Thermal Overload Protection (49), b) Short Circuit Protection (50) c) Earth Fault Protection (50N) d) Negative Phase Sequence Protection (46) e) Locked Rotor Protection (50LR) f) Motor start monitoring & Restart inhibit feature g) Number of starts limitation (66) h) Under Voltage protection with time delay (27M) i) Motor Differential protection (87M) j) VT Fuse-fail protection (60)		
3.02.02	Transformer Feeder Protections (Module Type DB/DBF/CCT) The Transformer protection relay shall be suitable for providing the following protections. a) Three Phase Over current and Earth Fault protection (50 & 50N) b) Transformer Differential protection (87T) c) Transformer trouble trips		
3.02.03	Protections for Incomers, Bus-couplers and Tie feeders (Module Type DC/DE/DD/DAET/DAE) The Incomer, Bus Coupler & Tie feeder protection relay shall be suitable for providing the following protections a) Restricted Earth Fault protection (64R) [Applicable only for DC/DAET] b) Stand by earth fault protection (51N) [Applicable only for DC] c) Synchronizing Check (25) d) Bus No-volt		
3.03.00	Other Protections and Control features		
3.03.01	Control of breakers / vacuum contactors shall be carried out from DDCMIS through hardwired control commands in the form of 24V DC signal. All close and trip commands from DDCMIS shall be hardwired through separate coupling relays to BI of numerical relays in form of 220 V DC signal.		
3.03.02	Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker / contactor trip circuit both in pre-trip and post-trip conditions.		
3.03.03	Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer functions shall be as required for the application. Timer functions shall be configurable for on & off delays as per requirement.		
3.03.04	The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker status monitoring, VT and CT supervision.		
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB SECTION B-05(B) MV& LV SWGR- PROTECTIONS, CONTROL & METERING
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CLAUSE NO.	TECHNICAL REQUIREMENT		
3.03.05	The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.		
3.03.06	At least 200-time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.		
3.03.07	Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be available on the user interface.		
3.03.08	20 Signals (both Analog & Digital) from each relay shall be communicated to DDCMIS on IEC 61850 protocol. Exact signals shall be finalised during detailed engineering.		
3.03.09	Sequence of events shall have 1ms resolution at device level.		
3.03.10	Measurement accuracy shall be 2 % for rated RMS Current and voltage		
3.03.11	It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.		
3.03.12	All motor feeders(>30KW) shall have 4-20mA analog output (current signal) for use in control logics in DDCMIS or for information in DDCMIS.		
3.03.13	GOOSE Controls shall be configured in the Numerical Relays for following functions. The response time of GOOSE interlocks shall be 10ms. (GOOSE Performance Class P1, Message Type 1A) (a) Inter tripping (b) Reverse Blocking (c) Earthing Interlocks		
4.00.00	ETHERNET SWITCH		
4.01.00	Ethernet Switch at Switchgear Level/Network Level: Ethernet switches shall be 'substation hardened ',19" rack mounted and shall comply with IEC61850 for communications and environment requirements. The Ethernet switches shall be of Layer 2 &managed type with four (4) Nos of Fibre Optic ports fully populated with SFP modules and Sixteen (16) / Eight(8) Copper ports to achieve the LAN configuration indicated in the drawing. These switches shall be mounted inside the switchgear panels and shall be suitable for accepting dual redundant power supplies. The FO ports shall be Single mode 1000Mbps ports. Copper ports shall be 10/100Mbpsports.The switch shall support RSTP/MSTP. The Ethernet Switch shall have feature of MAC binding per port and IEEE 801.1X radius Authentication for Port Security. Switch shall have feature to monitor the Port status over Modbus/SNMP Protocol & Port Configuration through Web Interface.		
4.02.00	Necessary software for configuration and real-time network monitoring shall be provided along with the Ethernet switches. Network monitoring feature shall be integrated with the HMI (Switchgear EWS) to provide complete network status.		
5.00.00	LAN CABLE & CONNECTOR		
5.01.00	Cat5e/Cat6 Ethernet cable shall be used for connecting the numerical relays to Ethernet switches. In case FO ports are proposed on the numerical relays, Ethernet switches shall also have suitable FO ports as per the quantity mentioned above. Further, additional FO patch cords of maximum length (quantity – 10% of total quantity of IEDs) shall be supplied to facilitate maintenance.		
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB SECTION B-05(B) MV& LV SWGR- PROTECTIONS, CONTROL & METERING
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CLAUSE NO.	TECHNICAL REQUIREMENT		
6.00.00	FO CABLE & CONNECTOR		
6.01.00	The Fibre Optic cable shall be armoured, Single-mode, graded index OMI (ISO/IEC 11801) of Diameter 125µm core / cladding with max attenuation of 1.52 dB/km at 1310nm wavelength & 1.0 dB/km at 1550nm wavelength. The cable should be suitable for operation at 1310/1550nm. The outer Sheath / Jacket of the FO Cable shall be Fire retardant.		
7.00.00	Ethernet Switch Box		
7.01.00	Ethernet Switch Box shall consist of the following: (a) Two nos. Ethernet switches (layer-3)at network level for Ring formation and taking data fromNumerical relay network (IEC-61850) and providing to DDCMIS(IEC-61850) (b) At least 2Nos (1 working + 1 standby) ventilation fans with monitoring (c) Arrangement for receiving and distributing auxiliary power supply to various equipment / circuits along with monitoring devices for incoming power supply (d) 1 LED light +1 Power Socket with Switch (e) Any other equipment / device necessary for completeness of the system		
7.02.00	The Network level Ethernet Switches shall be provided to network the various switchgears at different locations through LAN system. They shall also provide gateway between Numerical relays, HMI(Switchgear EWS) and DDCMIS.		
8.00.00	HMI(Switchgear Engineering Workstation) andLaptop		
8.01.00	HMI (Switchgear Engineering Workstation) shall consist of industrial gradePC withLaser printer connected to the relay network through Network level switches for online configuration/setting change of relays & ethernet switches. Automatic downloading and saving of the disturbance records & event files from relays through automatic DR download software tools provided by the relay vendorsshall also happenin this HMI. All the HMI PCs being offered in the system shall be as per the latest available configurations as on the date of bid opening. The minimum storage capacity shall be 1 TB, minimum RAM shall be 16GB and processor shall be I7/ equivalent or higher.Screen size shall be minimum 24 inches.		
8.02.00	Operating system of the HMI shall be 64-bit Windows Professional/Enterprise version andnecessary application software such as relays configuration & setting software, Disturbance record analysis software, Relays IEC 61850 configuration software, Ethernet Switches configuration software, Anti-virus software,etc shall be installed in the HMI.		
8.03.00	Licensed software for automatic downloading & saving of Disturbance records and Event records from Numerical relay to Switchgear Engineering works stations (EWS) shall also be provided& installed in HMI (Switchgear EWS).		
8.04.00	Laptops shall have same hardware configurationand software as for HMI PCexcept screen size which shall be 14 inches.		
8.05.00	HMI console(furniture i.e. Table with drawer & chair) shall be provided for each HMI. The console shall have space for keeping an additional PC (to be supplied as part of main plant & switchyard DC health monitoring system) also.		
9.00.00	SYSTEM SOFTWARE REQUIREMENTS AND DOCUMENTATION		
9.01.00	The Contractor shall provide all licensed software packages required by the system for meeting the intent, functional and parametric and performance requirements of the specification. All licenses (except anti-virus which shall be valid for 3 years) shall be valid for the continuous service life of the plant.		
10.00.00	SYSTEM SECURITY		
10.01.00	Security features shall be provided for Identification and authentication control at each level for safeguarding against unauthorized access.		
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CLAUSE NO.	TECHNICAL REQUIREMENT		
10.02.00	The contractor shall provide software locks / passwords to the Employer's engineers at site for all operating and application software at all levels.		
10.03.00	Security Audit for Switchgear Relay Network shall be done as mentioned in Section- VI, Part-B Sub-Section – IIIC-02 DDCMIS Annexure IIIC-02J. Suitable actions based on the findings of the security audit shall be carried out by the relay/ Ethernet switch supplier.		
10.04.00	STANDARDS AND COMPLIANCE The system shall comply with the latest versions of the following Standards and Specifications as a minimum:		
10.04.01	IEEE 1686-2013: IEEE Standard for Intelligent Electronic Devices Cyber Security Capabilities.		
10.04.02	IEC-62443-4-2: Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components.		
10.04.03	IEC TS 62351-6: Power systems management and associated information exchange - Data and communications security - Part 6: Security for IEC 61850.		
11.00.00	FAST BUS TRANSFER SYSTEM		
11.01.01	The Fast Bus Transfer System (FBTS) shall be provided complete with panels and necessary wiring in order to meet the intended specification.		
11.01.02	The Fast Bus Transfer System (FBTS) shall be microprocessor based which shall facilitate fast and safe transfer of supply from Unit to Station, Station to Unit and Between Unit Auxiliary transformers under Manual & Automatic modes. The FBTS shall have features to provide Fast, In-phase and Slow changeovers as per the system conditions. The priority of transfer attempts shall be in the above order.		
11.01.03	FBT shall have IEC 61850 port to communicate with DDCMIS similar to other numerical relays.		
12.00.00	ENGINEERING		
12.01.00	Complete engineering including the following: (a) Development of Module Type-wise Schemes with hardwired & soft logics. (b) Configuration of Feeder IED including Protection and Control logics (c) Configuration of Fast Bus Transfer Systems (d) Relay Network Design based on reliability & speed (e) Configuration and application development of Switchgear relay network as required for real time monitoring& data acquisition (f) Preparation & Submission of mimic document for Relay Network architecture for helping DDCMIS supplier to create the dynamic/static mimic in DDCMIS for Network monitoring (g) Preparation of I/O lists for each module type for integration with DDCMIS on IEC-61850 protocol (h) The integration of Switchgear Relay Network with Switchgear DDCMIS shall be finalized in consultation with the Switchgear DDCMIS supplier in Technical Co-ordination meetings (TCMs) and the same shall be tested as a part of Major Design Feature testing with a prototype system of the offered Switchgear relay Network system, at the works of the DDCMIS supplier or any other place approved by Employer. (i) The required. ICD / .CID files of the Numerical relays under MV Switchgears for the integration with the DDCMIS shall be provided by the Numerical relay vendor along		
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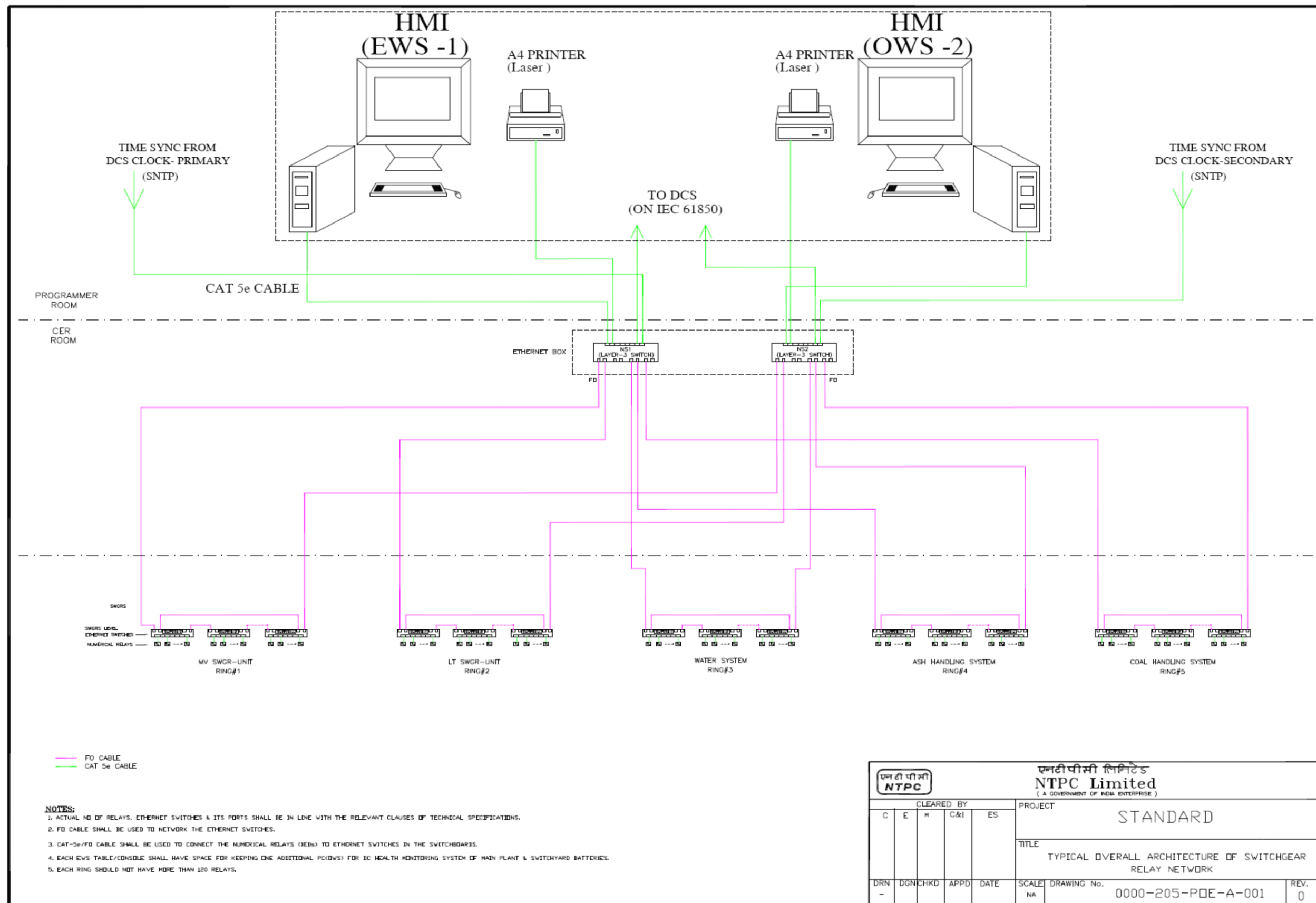
CLAUSE NO.	TECHNICAL REQUIREMENT			
	with necessary engineering support as and when required during detail engineering. (j) During the Factory Acceptance Test (FAT)of the DDCMIS, Relay & Ethernet Switch supplier will arrange a prototype ring with at least three ethernet switches (L2) with one numerical relay of each type and L3 Switches network, at the works of the DDCMIS supplier along with the necessary engineering support. Exact test setup shall be finalized during detailed engineering.			
12.02.00	Numerical relay configuration for all relays being supplied under the package shall be carried out in line with the approved schematics and shall be submitted for Employer's approval. Setting calculations and relay settings configured in relay software for all relays shall be submitted for Employer's approval. Approved relay configuration / settings files shall be loaded in all the relays prior to dispatch to site.			
13.00.00	TRAINING			
13.01.00	The vendor shall arrange for training on system design, engineering, operation and maintenance of Numerical relays & Numerical relay Network system at the principal's facility and at site as follows:			
13.02.00	Training at principals works (Relay Manufacturer) in the following areas:			
	a) Basics of Feeder, Transformer and Motor Protection for IEC 61850 Numerical relay and detail discussion on functions available in the relays. b) Relay configurations and hands on practice of preparation of logic& settings, .CID files through relay software tools and relay GOOSE Logics. c) Interfacing / communication of relay with software: uploading / downloading of logic. d) Secondary injection testing of provided function blocks and guidelines for relay settings. DR downloading and analysis for Fault diagnostics e) Common problems faced and trouble shooting			
13.03.00	The Scope shall include providing training in the areas stated above for five (5) No Executives from Engineering, Site Erection, and O & M for a duration of five (5) days. The cost of training including boarding & lodging and local transportation shall be in the vendor's scope. Training Workshop at Site Workshop Training at site shall aim for familiarization of Site Engineers for commissioning and day to day O & M of Numerical Relays and Numerical Relay Network and trouble shooting. The scope shall include Two No's of Numerical Relay and Numerical Relay Network workshops and Training for a batch of 20 Engineers at Project Site. One such Workshop shall be organized before the commissioning of First MV Switchboard and the Second workshop shall be conducted before Unit Commissioning. Employer shall provide the required Infrastructure such as Training Conference room, Projection systems etc.			
14.00.00	AUXILIARY POWER SUPPLY			
14.01.00	The numerical relays & Ethernet switches being installed at switchboard shall be suitable for auxiliary power supply 240V DC/110V DC with tolerance of 80% to 120 % of rated voltage & shall be finalized during detailed engineering. Ethernet switches shall have provision to receive dual redundant power supplies. However, other network components such as Network level switches, HMI, etc. shall be suitable for 240V AC & redundant 240V AC UPS supply for these components shall be provided.			
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CLAUSE NO.	TECHNICAL REQUIREMENT																																		
15.00.00	INPUT / OUTPUT INTERFACE, FILTERS AND OPTICAL ISOLATION																																		
15.01.00	Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature.																																		
15.02.00	All I/Os shall have optical isolation. Analog inputs shall be protected against switching surges, harmonics etc.																																		
15.03.00	No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the plant earth mat.																																		
16.00.00	TIME SYNCHRONIZATION																																		
16.01.00	Time clock synchronization equipment provided for the DDCMIS shall have SNTP port and all the clocks of the numerical relays, Ethernet Switches, HMI, etc., shall be time synchronized on SNTP with the same. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system. Necessary cable (with protective conduit, if required) for connecting the GPS receiver / clock to the Network level switches shall also be in bidder's scope.																																		
16.02.00	One Digital display of time shall be provided in the Network level Ethernet switch box.																																		
17.00.00	TYPE TESTS AND FACTORY ACCEPTANCE TESTS																																		
17.01.00	Type test reports for the following tests on the model of the relays & Ethernet switches being offered shall be submitted for Employer's review. Type Tests of Ethernet Switches shall have been conducted at NABL accredited Lab.																																		
	<table><tr><th>S. No.</th><th>TEST ITEMS</th><th>Standard</th></tr><tr><td>1</td><td>Dimensions of structure and visual inspection</td><td>IEC 60297-3-101</td></tr><tr><td rowspan="3">2</td><td>Functional requirements:</td><td>Relevant</td></tr><tr><td>– Steady-state simulation</td><td>IEC 60255-100 series</td></tr><tr><td>– Dynamic simulation</td><td></td></tr><tr><td rowspan="2">3</td><td>Product safety requirements</td><td rowspan="2">IEC 60255-27</td></tr><tr><td>(including the dielectric tests and thermal short time rating)</td></tr><tr><td rowspan="3">4</td><td>EMC requirements:</td><td rowspan="3">IEC 60255-26</td></tr><tr><td>– Emission</td></tr><tr><td>– Immunity</td></tr><tr><td rowspan="3">5</td><td>Energizing quantities:</td><td></td></tr><tr><td>– Burden</td><td>N/A</td></tr><tr><td>– Change of auxiliary energizing quantity</td><td>IEC 60255-11</td></tr><tr><td>6</td><td>Contact performance</td><td>N/A</td></tr></table>	S. No.	TEST ITEMS	Standard	1	Dimensions of structure and visual inspection	IEC 60297-3-101	2	Functional requirements:	Relevant	– Steady-state simulation	IEC 60255-100 series	– Dynamic simulation		3	Product safety requirements	IEC 60255-27	(including the dielectric tests and thermal short time rating)	4	EMC requirements:	IEC 60255-26	– Emission	– Immunity	5	Energizing quantities:		– Burden	N/A	– Change of auxiliary energizing quantity	IEC 60255-11	6	Contact performance	N/A		
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CLAUSE NO.	TECHNICAL REQUIREMENT				
	7	Communication requirements	Relevant IEC protocol standards		
	8	Climatic environmental requirements:	IEC 60068-2-14,		
		– Cold	IEC 60068-2-1,		
		– Dry heat	IEC 60068-2-2,		
		– Change of temperature	IEC 60068-2-78,		
		– Damp heat	IEC 60068-2-30, IEC 60255-27		
	9	Mechanical requirements: – Shock	IEC 60255-21-1,		
		– Vibration	IEC 60255-21-2,		
		– Bump	IEC 60255-21-3		
		– Seismic			
	10	Enclosure protection	IEC 60529, IEC 60255-27		
	18.00.00	ERECTION AND COMMISSIONING AND SAT FOR NUMERICAL RELAYS &RELAY NETWORK SYSTEMS			
	18.01.00	The contractor shall prepare an erection guideline and commissioning Procedure, SAT procedure for the Relay Network system and submit to Employer for review and approvals.			
	19.00.00	RELAY TEST EQUIPMENT			
	19.01.00	The required relay test equipment shall comprise the following:			
	(a)	One 3 phase (4 Voltage and 6 current sources) dynamic portable relay test system for allowing dynamic and steady state testing.			
	(b)	Any other auxiliary items required for comprehensive protection testing all types of the protection relays supplied under this contract.			
19.02.00	It shall have the capability to replay the Disturbance / Fault records acquired by the numerical relays in IEEE / COMTRADE format or EMTP simulations, to facilitate dynamic testing of all the numerical relays supplied under this contract. The required software for steady state/dynamic testing of all the numerical protection relays along with a laptop dedicated for the testing shall also be supplied. The relay test set shall be suitable for IEC 61850 compliance testing with required no. of RJ45, FO and USB Ports. The test set shall have min 8 nos. (GI) binary inputs and 4 nos. (GI) binary outputs. The associated software for automated relay testing and IEC61850 GOOSE/GSSE Configuration shall also be supplied.				
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CLEARED BY				
C	E	M	C&I	ES
PROJECT				
STANDARD				
TITLE				
TYPICAL OVERALL ARCHITECTURE OF SWITCHGEAR RELAY NETWORK				
DRN	DCNCHKD	APPD	DATE	SCALE
-				NA
DRAWING No.				REV.
0000-205-PDE-A-001				0



SUB-SECTION-B – 06

L.T. SWITCHGEAR & LT BUSDUCTS

CLAUSE NO.	TECHNICAL REQUIREMENTS 			
1.00.00	CODES AND STANDARDS			
	IS: 5	Colours for ready-mixed paints and enamels.		
	IS: 694	PVC insulated cables for working voltages upto and including 1100V.		
	IS: 722	A.C. Electricity Meters		
	IS: 1248	Electrical Indicating instruments		
	IS/IEC: 60947-1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear		
	IS/IEC: 60947-2	A.C. circuit Breakers, MCCB, MCB, MPCB		
	IS: 2551	Danger Notice Plates		
	IS: 2629	Hot dip galvanising		
	IS: 2705	Current Transformers		
	IS/IEC: 60947-4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC		
	IS: 3043	Code of practice for earthing.		
	IS: 3072	Code of practice for installation and maintenance of Switchgear		
	IS: 3156	Voltage Transformers		
	IS: 3202	Code of practice for climate proofing of electrical equipment.		
	IS: 3231	Electrical relays for power system protection.		
	IS/IEC 60947	Air-Break Switches, air break disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.		
	IS/IEC 60947-1	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.		
	IS: 5082	Wrought Aluminium and Aluminium alloys for electrical purposes.		
	IS: 6005	Code of practice of phosphating of iron and steel.		
	IS/IEC 60947-5-1	LV switchgear and Control gear Control current devices and switching element.		
	IS: 8623 / IEC: 61439-1/2	Low Voltage Switchgear & Control gear assemblies		
	IS: 8686	Static Relays		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS: 13703 / IEC: 60269	HRC Cartridge fuses		
	IS: 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.		
	IS: 11171	Specification for dry type transformers.		
	IEC: 60255	Electrical Relays		
	IEC: 61850	Communication networks and systems in substations		
	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals		
	IS: 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.		
	IEC: 60947-7-1	Terminal blocks for Copper conductors		
	IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips		
	2.00.00	TECHNICAL PARAMETERS		
2.01.00	Power Supply			
2.01.01	AC SYSTEM			
	1)	Voltage	415 V $\pm$ 10%,3 Phase, 4 wire, solidly earthed	
	2)	Frequency	50 Hz +/- 5%	
	3)	Combined variation (in volts & frequency)	10% absolute sum	
	4)	Fault Level	50kA(RMS)	
2.01.02	DC SYSTEM			
	1)	System Voltage	220VDC 2-Wire, Unearthed	
	2)	Fault Level	20 kA	
2.01.03	CONTROL SUPPLY VOLTAGE			
	1)	(i) Closing coil of circuit breaker	220V DC/110V DC	
	2)	Spring charging motor	220V DC/110V DC	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.02.00 2.03.00 				



CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.05.00	2)	Type	Metal enclosed, indoor, floor-mounted, Free Standing Type	
	3)	Degree of Protection	IP:52 (IP:42 for Busbar chamber, 1600A & above) As per IS/IEC:60947 IP65: Paddle Feeder and Travelling Tripper MCC IP55: Outdoor Panels enclosed in Stainless Steel Mounted on 500 mm Pedestal	
	4	Design	Complete Closed Door Design	
	5	Internal Arc Classification	50KA,0.5 sec	
	6	Cable Alley Compartment	Form-4B as per IEC-61439	
	7	Gasket	Steel Reinforced EPDM /PU Foam gaskets	
	8)	Height	2450mm max	
	9)	Clearances	25 mm: (Ph-Ph)/(Ph-earth) Insulation Sleeves/Barriers shall be provided for clearance less than 25 mm Incomer Rear Door and Busbar-400mm	
	CIRCUIT BREAKER			
	1)	Type	Air break spring charged stored energy type	
	2)	Operating duty	O-3 min-CO-3 min-CO	
	3)	Symmetrical interrupting	50KA(RMS)	
	4)	Short circuit rating	105KA(PEAK)	
	5)	Short Circuit Breaking current		
		a) AC Component	50KA(RMS)	
		b) DC Component	As per IS/IEC 60947	
	6)	Short time withstand	50KA(RMS) for 1 s	
7)	No of aux. contacts	4 NO + 4 NC for DDCMIS interface 6NO+6NC Auxiliary Contact(directly operated from breaker operated Mechanism)		
8)	Antipumping Feature	Both Mechanical and Electrical		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.06.00	METERS		
	1)	Accuracy Class	2.0
	2)	One min. power frequency withstand test voltage	2.0 kV(RMS)
2.07.00	Current Transformers		
	1)	Type	Cast Resin Bar Primary / Nylon Casing
	2)	Voltage class and frequency	650 V, 50 HZ
	3)	Class of insulation	E or better
	4)	Rated Secondary Current	1 A
	5)	Accuracy class & burden	
	a)	For protection	5P20, 5VA PS Class for REF
	b)	For metering	class 1.0, 5VA (min) class 0.2s, 5VA (min) for feeders indicated in SLD ,if any
	6)	Instrument Security Factor (ISF) for metering CT	5
	7)	Short time withstand	
	a)	For CT Associated with circuit breaker	50kA(RMS) for 1 sec
	b)	For CT Associated with MCCB protected feeders	Prospective current of 50kA(RMS) for the MCCB clearing time
	8)	Dynamic withstand	
	a)	For CTs Associated with circuit breaker	105kA(PEAK)
	b)	For CT Associated with MCCB protected feeders	Prospective current of 105kA(PEAK) as Limited by MCCB
2.08.00	BUSDUCT (NON-SEGREGATED, AIR INSULATED TYPE)		
	1)	Rating	As per requirement /Sizing Calculation
	1)	Type	Non-Segregated
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.09.00	2) 3) 4) 5) 8) 9) 10) 11)	One minute power frequency withstand voltage	2.5 kV
		One second short ckt withstand current	50kA(RMS)
		Momentary dynamic current withstand	105kA(PEAK)
		Enclosure	3mm Al Alloy Rectangular(IP:55) Al sheet flange protection hood for outdoor
		Gasket	Steel Reinforced EPDM /PU Foam gaskets
		Conductor	Material: Alumunium Clearance:25 mm(Min)
		Steel Structure	Hot Dipped Galvanised
		Earthing	GI of Adequate Size along full length
	BUSDUCT (SANDWICH TYPE)		
	1)	Type	Bus Trunking
	2)	Rated Insulation voltage	1000V
	3)	One second short ckt withstand current	50KA(RMS)
	4)	Momentary dynamic current withstand	105KA(PEAK)
	5)	Power frequency withstand voltage	3.5kv
	6)	Impulse withstand voltage	8kV
	7)	Insulation	Class F
	8)	Conductor	Material: AL/Cu
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
2.10.00	9)	Enclosure	CRCA/GI:1.6mm Al:2.5mm DOP:-IP:55
	10)	Gasket	Steel Reinforced EPDM /PU Foam gaskets
	11)	Earthing	GI of Adequate Size along full length
	VOLTAGE TRANSFORMERS		
	1)	Type	Cast Resin
	2)	Voltage Ratio	415 / 110 V for line PT 415/ $\sqrt{3}$ / 110/ $\sqrt{3}$ V for Bus PT
	3)	Method of Construction	V-V
	4)	Accuracy Class	0.5 0.2 for feeders indicated in SLD ,if any
	5)	Rated Voltage factor	1.1continuous, 1.5 for 30 sec.
	6)	Class of insulation	E or better
	7)	One minute power frequency withstand voltage	2.5 KV
2.11.00	HRC FUSES		
2.12.00	1)	Voltage Class	650 Volts
	2)	Rupturing capacity	80 kA (rms) for AC ckt., 20 kA for DC ckt.
	CONTACTORS		
	1)	Type	Air break electro magnetic
	2)	Utilising Category	AC3 of IS/IEC 60947 for non reversible AC4 of IS/IEC 60947 for reversible drives DC3 for DC contactor
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
2.13.00	3)	Operating Coil Voltage	(i)110V AC(-15%+10%) Drop out voltage-less than 70% Guaranteed Drop out at 20% of rated voltage (ii)220V DC((-15%+10%)
	Relays		
2.14.00	1)	Power frequency withstand voltage	2.5 kV for 1 sec. or 2.0 kV for 1 min.
2.15.00	CONTROL TRANSFORMERS		
	1)	Type	Dry / Cast Resin
	2)	Voltage Ratio	415 / 110 V with taps $\pm$ 5% in steps of 2.5%
	3)	Class of insulation	Class-B or better
	4)	One minute power frequency withstand voltage	2.5 kV
	5)	Rating	1.5 X Adequate for application.
2.16.00	LIGHTING TRANSFORMER / WELDING TRANSFORMER		
	1)	Type & Rating	Dry type / 100KVA(Welding TRF), 50KVA(Minimum)(Lighting TRF)
	2)	Voltage Ratio	415/415V, +/- 5% taps in steps of 2.5%
	3)	Class of insulation	B or better
	4)	One minute power frequency withstand voltage	2.5 KV
	5)	Enclosure protection	IP-42
	6)	Type Test	As per IS 2026
	7)	Fault level	3-5 KA secondary side
2.16.00	TRANSDUCERS		
	1)	Current transducers	
		a) Input	0-1 A (CT secondary)
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.17.00	b)	Rated frequency	50Hz
	c)	Output	4-20 mA (2 Nos. decoupled)
	d)	Over current	Transducer for motor current ammeters shall be capable of withstanding min. 6 times CT sec. current of 1A for a min period of 30 seconds
	e)	Accuracy	1.0
	2)	Voltage Transducers	
	a)	Input	500 V,50 Hz (for AC)/250 V / 125 V DC (for DC)
	b)	Output	4-20 mA (2 Nos. decoupled)
	c)	Accuracy	1.0
	MCCB& MPCB		
	1)	Type	Thermal Magnetic based(in built front adjustable releases
2)	Rated insulation level	690V	
3)	Rated ultimate & Service S.C. breaking capacity	50 kA	
4)	Rated making capacity	105 kA	
5)	Utilization category	A	
2.18.00	NOT USED		
2.19.00	MCB		
2.20.00	1)	Rated voltage	415V/240V/110V AC240V DC
	2)	Current breaking Capacity	10 KA
	3)	Characteristic Curve	C or above
	AC & DC MCCB Box		
	1)	Construction	(i)Metal Enclosed Fixed Type CRCA:2mm structure :1.6mm enclosure Or (ii)Poly Corbonate (a) Halogen Free, flame Retardant (UL-94,V0) (b) Thickness:4mm (iii) UL224 sleeved Busbars
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CLAUSE NO.	TECHNICAL REQUIREMENTS																	
2.21.00	2)	Degree of Protection	Indoor: IP52 Outdoor: IP54															
	3)	Characteristic Curve	C or above															
2.22.00	Earth Bus and Earthing																	
	Material	GS/Cu/Al of Sufficient cross section Separate Copper Earth bus for Electronic Earthing of IMCs																
2.23.00	Internal Wiring and Control Terminal Blocks																	
	<table><tr><td colspan="3">Control Terminal Blocks</td></tr><tr><td>1)</td><td>Rating</td><td colspan="2">650V grade , 10 A ,6.6 polyamide UL 94Separate Copper Earth bus for Electronic Earthing of IMCs</td></tr><tr><td>2)</td><td>Type</td><td colspan="2">Screw less ,push in technology(IEC 60947-7-1 and UL certified)</td></tr><tr><td>3)</td><td>Spare</td><td colspan="2">20%</td></tr></table>				Control Terminal Blocks			1)	Rating	650V grade , 10 A ,6.6 polyamide UL 94Separate Copper Earth bus for Electronic Earthing of IMCs		2)	Type	Screw less ,push in technology(IEC 60947-7-1 and UL certified)		3)	Spare	20%
Control Terminal Blocks																		
1)	Rating	650V grade , 10 A ,6.6 polyamide UL 94Separate Copper Earth bus for Electronic Earthing of IMCs																
2)	Type	Screw less ,push in technology(IEC 60947-7-1 and UL certified)																
3)	Spare	20%																
3.00.00	LOCAL/EMERGENCY PUSH BOTTON																	
	1)	Construction	CRCA/Die Cast Al:1.6mm enclosure Or (ii)Poly Corbonate (a) Halogen Free, flame Retardant(UL-94,V0) (b) Thickness:4mm (iii) UL224 sleeved Busbars															
3.01.00	2)	Degree of Protection	IP55 IP65(Dusty Area)															
	3)	Characteristic Curve	C or above															
3.00.00	4)	Contacts	Latched Type EPB 2NO+2NC															
	CONSTRUCTIONAL DETAILS OF SWITCHBOARDS																	
3.01.00	All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments:																	
	(a.) BUSBAR COMPARTMENT																	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	A completely enclosed bus bar compartment shall be provided for the horizontal and vertical bus bars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power bus bars shall be in separate compartments. (b.) SWITCHGEAR / FEEDER COMPARTMENT All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. Two-tier breaker arrangement in a vertical section shall be offered for outgoing breaker feeders of rating up to 1600A. Fixed part of vertical busbar and moving part of draw-out modules for power connection shall be of Silver/Tinned plated Copper only. No live parts shall be accessible with equipment drawn out. The Module compartment door shall have external padlocking facility with MCC frame/fixed structure. The MCC module will have a hole with a grommet on side plate of the module truck for taking Profibus DP connector with 2 nos. armoured profibus DP cables from Cable alley to IMC's profibus DP port for making daisy chain connection of IMCs by DDCMIS vendor in an MCC panel. Alternatively, good quality Secondary Isolating Contacts(SICs) can be offered for Profibus DP communication port connection & isolation between moving & fixed parts of MCC. A separate compartment shall be provided for relays and other control devices associated with a circuit breaker. For breaker controlled motor feeders, an aux. relay shall be provided for taking Local push button station(EPB) "normally open (NO)" contact input from field and provide potential free output to DDCMIS to avoid probable mixing of switchgear control voltage with DDCMIS 24V DC voltage. This aux. relay shall have 2NO+2NC contacts.			
3.02.00	Wherever two breaker compartments are provided in the same vertical section form 4B separation and separate vertical busbar chamber shall be provided For Incomer panel suitable interlock shall be provided to prevent opening of rear cover, in case incoming supply is ON/Line is live and for Bus-coupler panel suitable interlock shall be provided to prevent opening of rear cover, in case either of the bus-section is in charged condition.			
3.03.00	All 415V air circuit breaker switchgear panels shall be of single-front type. MCCs and DBs shall be of single-front / double-front construction as per the requirements. All ACDBs, DCDBs and Solenoid Valve DBs shall be of fixed module type. MCCs located on the Stacker reclaimers, Paddle Feeders, Travelling Trippers shall be fixed type, single front.			
3.04.00	For modules of size more than 300 mm, symmetric guides not less than 4 nos shall be provided for smooth removal or insertion of module. All identical module chassis of same size shall be fully interchangeable without having to carryout any modifications. Suitable interlock shall be provided in DCDB for prevention of opening of Isolator (Incomer) when the bus coupler is open and vice-versa.			
3.05.00	All draw-out modules shall be provided with "Closed door operation" feature wherein movement of the module from "Isolated" position to "Test" position and to "Service" position & vice-versa and power ON / OFF operation of the module shall be possible only with the module door closed condition. Degree of protection of the panel shall be maintained in both "Service", "Test" and "Isolated" positions. Module door shall open only when module is in "Isolated" position and "Power off" condition. Interlock shall be provided to prevent the change of module state from "Isolated" to "Test" position and to "Service" position or vice-versa, if Main Switch/MCCB/MPCB of the module is kept in ON condition. All the modules shall be of standard width only and no half width, quarter width etc sized modules shall be acceptable. It shall be possible to pad lock the module door irrespective of state of module i.e. "Service", "Test" or "Isolated". Module Operated Automatic safety shutter shall be provided to cover all the live power terminals, in case the module is taken out from the panel. 2 nos of Dummy modules of each size to fill in module being taken out for maintenance purpose shall be provided in each switchgear room, in case module door is part of module. These Dummy Modules shall be fitted in switchboard as vacant modules having no cut out on			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	back side and cable alley side. In case door is hinged to the panel, 2 nos of blanking plates of each size need to be provided. Minimum 10mm of gap shall be ensured between busbar and moving power contact tips while module is in “Test” position to ensure user safety. It shall not be possible to open the rear door of incomer and buscoupler breaker modules when the incoming power source are in live condition.			
3.06.00	Air Circuit Breakers Modules shall be provided with “Closed door operation” feature wherein movement of the module from “Isolated” position to “Test” Position and then to “Service” position & vice-versa and power ON / OFF operation of the module shall be possible only with the module door closed condition. Degree of protection of the panel shall be maintained in both “Test” and “Service” positions. Module door shall open only when module is in “Isolated” position and “Power off” condition.			
3.07.00	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.			
3.08.00	The compartment door of fixed type modules shall be interlocked to prevent opening while the MCCB/MPCB in “ON” condition.			
3.09.00	Employer reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.			
3.10.00	The Contractor shall provide adopter panel / dummy panel required to meet various configuration / arrangement of busbars/layout requirement adopted by the Contractor. The Switchboards fed from indoor transformer will be flange connected to the same and the same shall be located as close as desirable to the transformer.			
3.11.00	Wireless temperature monitoring system to be provided and same shall be integrated to DDCMIS/ separate HMI. Temperature sensors shall be installed in all relevant joints, contact joints etc. as per the standard OEM Practice, however Position of such sensors shall be decided at the time of detailed engineering. This shall be provided only for the following switchgears:			
	USS(Unit service switchgear), BPMCC(Boiler PMCC), TPMCC(Turbine PMCC) and UES(Unit emergency switchgear)			
4.00.00	PROTOTYPE PANELS			
	In order to establish the compliance with the requirements of this technical specification, prototype panels shall be made and offered for the Employer’s inspection and approval before the start of bulk manufacturing of panels for this project. The exact configuration of such prototype panels shall be finalized during detailed engineering. The switchgear shall be modified complying the observation marked during Prototype inspection (if any)			
5.00.00	CONSTRUCTIONAL DETAILS OF AC & DC MCCB BOX			
5.01.00	Each DC MCCB Box shall comprise of the following :			
	(a.) 1 no. 63 A DP MCCB as incomer			
	(b.) 100 A fully insulated (PVC sleeved,UL224) busbars.			
	(c.) 8 nos. 16A outgoing DPMCCB feeders.			
	(d.) 1 no. auxiliary contactor for supply monitoring.			
	(e.) 1 no. Blue LED indicating lamp-			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.02.00	Each AC MCCB Box shall comprise of the following : (a.) 1 no. 63A TPN MCCB as incomer. (b.) 100 A, 3-phase, 4-wire, fully insulated (PVC sleeved,UL224) busbars. (c.) 9 nos. 16 A DP MCCB and 3 nos. 16 A TPN MCCB units as outgoing feeders. (d.) 3 nos. LED indicating lamps (R, Y, B) for incoming supply monitoring.			
6.00.00	POWER BUSBARS AND INSULATORS			
6.01.00	Two separate sets of vertical busbars shall be provided in each panel of double front MCCs / DBs. Interleaving arrangement for busbars shall be adopted for switchboards with a rating of more than 1600A.			
7.00.00	Intelligent Motor Controller (IMC) 1. Each motor/heater feeder shall consist of MPCB/MCCB (with S/C release only), Power contactor &intelligent motor controller (IMC) to ensure Type-2 Co-ordination. If the ESP controller and rapping motor are provided in the ESP switchgear, same shall be with IMC having MPCB/MCCB. If separate controller is provided and only supply feeder is envisaged from ESP Switchgear, the requirement of IMC may be excluded. 2. The motor feeders shall be provided with Intelligent Motor Controller (IMC) in place of overload relay, in the power circuit. Intelligent Motor Controller (IMC) shall provide protection, metering, control, monitoring and historical logging for 1ϕ and 3ϕ AC induction motors using integral current transformers (CTs) or external CTs and line-line voltages (415V). 3. The IMC should conform to IEC 60947-4-1& 60947-8 for overload protections. 4. Degree of protection shall be minimum IP20 for the IMC and IP54 for its HMI. 5. The IMC shall be able to perform its functions without fail inside MCC modules which are kept in non-AC normal ventilated Switchgear rooms of the power plant. 6. Electronic modules of IMCs and other associated electronic modules shall be G3 / GX compliant with Conformal protective coating in line with ISA S71.1 / Class 3C3 (3C4) in line with IEC 60721-3-3 for protection against air pollution and harsh environments. The conformal coating version shall be a standard product from the manufacturer's factory. The hardware that is being conformal coated locally shall not be acceptable. 7. IMC's basic module and Expansion Module (if any) rated Power supply voltage shall be 110 V AC, 50 Hz. Binary input interrogation voltage shall also be 110 V AC, 50 Hz. Binary output shall be rated for 6A, 110 V AC. Above 110V AC supply for the IMC shall be tapped from respective MCC module control supply itself. 8. Quantity of Intelligent Basic Module, no. of Expansion modules and all other accessories shall be selected to meet the intent of the specifications. However, minute details shall be finalized during detailed engineering. 9. Voltage measurement input of IMC shall be capable of taking 415V directly from line & no voltage transformer (VT) should be required. 10. The IMC shall be pre-programmed with basic software based on all type of feeders in bidder's scope. The fine tuning/ limit values shall be done at the time of commissioning of the MCC panels. 11. The IMC shall have following protection functions, control functions and other operation & diagnostic features but not limited to these: a) PROTECTION FUNCTIONS i) Overload (I²t) Protection with site selectable Trip class 5 to 30 ii) Current imbalance iii) No. of starts/hr limitation iv) Stall Protection during start			
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CLAUSE NO.	TECHNICAL REQUIREMENTS	
	v) Load Jam protection during running b) <u>CONTROL FUNCTIONS</u> i) Close / Trip Command ii) Reversing starter c) The IMC will have standard function control blocks for various functions: i) Watch dog facility ii) Ready to start iii) External wiring iv) Emergency stop v) External check-back signal vi) DP fault vii) Test 1 with shut-down viii) Test 2 without shut-down ix) Reset d) <u>OPERATING AND DIAGNOSTICS DATA</u> The IMC shall continuously monitor and provide the following data for display (local / remote). a) For DK2/DN1/HTR module: i) 3-Phase currents ii) Motor ON / OFF status iii) Motor Fault / Switchgear Disturbance iv) Overload trip status v) Overload alarm status vi) Operating hours vii) Number of switching operations viii) Number of overload trips ix) At least last 5 trip data with time stamping in non-volatile memory of IMC in FIFO sequence b) For DK21 module: In addition to the above for DK2 module, following measurement data shall also be provided. x) 3 Phase Voltages xi) 3 Phase Power xii) 3 phase Energy Contractor shall provide complete list of data items available for cyclic and acyclic data communication on Profibus DP for DDCMIS interface and diagnostics. 12. The IMC shall have provision for 'Manual' Reset facility on panel facia after overload trip of drive. 13. The IMC shall have at least 6 digital Inputs & 3 programmable potential free digital outputs. These DIs & DOs may be inbuilt with basic IMC module or may be provided with add-on expansion modules. Expansion modules shall be powered with the basic module. Further, the IMC shall have following LED indications: i) Controller healthy ii) Controller fault iii) Controller power supply healthy 14. <u>Configuration / programming:</u> i) IMC shall be programmable from IMC's HMI,PC(laptop) and DDCMIS. ii) IMC shall be configurable to operate as an overload relay iii) Digital outputs shall be potential free and independent, each output shall be connectable to different field voltages	
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
	iv) All licensed software required for configuration / programming / parameterization / fault diagnostics of IMCs along with software licenses shall be supplied as a part of the package. v) All interface files like DTM & GSD files shall be provided for interfacing IMCs with DDCMIS. 15. User Interface: i) Local HMI shall be provided with each IMC. The HMI shall be mounted on front of the MCC module for easy access to the operator to view measurement parameters & fault/trip status. ii) HMI shall have the capability of uploading / downloading parameters to IMC. iii) The address & other communication parameters shall be configurable from HMI. iv) HMI shall be internally powered by IMC and no additional power supply shall be required. Simple cables with RJ45 connectors or RS232 connector or USB cable shall be sufficient for connection to IMC. IMC shall have dedicated port for connection to IMC's HMI/PC(laptop). v) HMI shall have the simple text display in English. vi) HMI shall have operate / reset buttons. vii) HMI shall display the operating data, status, faults, counters & warnings information. 16. Communication to DDCMIS: The IMC shall be interfaced with DDCMIS on Profibus DP protocol for complete remote operation and control along with detailed diagnostics. Necessary support along with required software and hardware accessories shall be provided by the LT Switchgear vendor/IMC vendor to DDCMIS vendor while integration of IMCs with DDCMIS. The connection/looping/ interface of IMC with DDCMIS shall be as per philosophy defined in C&I section(Scope of work, Part-A and Annexure-IIIC02-K, Part-B of Technical Specification). 17. One PG/PG port connector shall be offered for each IMC. Profibus connector shall be fast-connect type. 18. Profibus cable shall be routed in a separate pre-fitted closed PVC tray inside MCC panels. The tray shall be located in such way that interference due to 220V DC/110V AC/240V AC available in Switchgear/MCC panels can be minimized on Profibus cables.		
8.00.00	NUMERICAL RELAYS & NETWORKING Please refer Protection, Control and Monitoring chapter of MV&LV Switchgear.		
9.00.00	Power Cable Termination		
9.01.00	Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded Aluminium conductor, PVC/ XLPE insulated, armored / unarmoured and PVC sheathed cables. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc. for cables shall be provided by the contractor to suit the final cable sizes.		
10.00.00	BUS TRUNKING SYSTEM (SANDWICH TYPE BUSDUCT)		
10.01.00	Three phase Bus trunking system conforming to IEC 61439-6 / IS 8623 (Parts 1 & 2) shall be provided for connecting the Main and Standby DG sets to Unit Emergency Switchgears.		
10.02.00	Enclosures shall be provided with flanged ends with drilling dimensions to suit the flanges at the switchgear and DG terminals. Any adapter boxes required for this purpose are in the contractor's scope of supply. The flanges shall be provided with gaskets, nuts, bolts, etc.		
11.00.00	TEMPERATURE –RISE		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.02.00	(e.) Intelligent Motor Controller(IMC) for Electromagnetic Compatibility (EMC) & other requirements as per applicable standards			
	Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for Employer's review.			
	S. No.	TEST ITEMS	Standard	
	1	Dimensions of structure and visual inspection	IEC 60297-3-101	
	2	Functional requirements:	Relevant	
		– Steady-state simulation	IEC 60255-100	
		– Dynamic simulation	series	
	3	Product safety requirements	IEC 60255-27	
		(including the dielectric tests and thermal short time rating)		
	4	EMC requirements:	IEC 60255-26	
		– Emission		
		– Immunity		
	5	Energizing quantities:		
		– Burden	N/A	
		– Change of auxiliary energizing quantity	IEC 60255-11	
	6	Contact performance	N/A	
	7	Communication requirements	Relevant IEC protocol standards	
	8	Climatic environmental requirements:	IEC 60068-2-14,	
		– Cold	IEC 60068-2-1,	
– Dry heat		IEC 60068-2-2,		
– Change of temperature		IEC 60068-2-78,		
– Damp heat		IEC 60068-2-30, IEC 60255-27		
9	Mechanical requirements: – Shock	IEC 60255-21-1,		
	– Vibration	IEC 60255-21-2,		
	– Bump	IEC 60255-21-3		
	– Seismic			
10	Enclosure protection	IEC 60529, IEC 60255-27		
14.03.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.			
14.04.00	The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.			
14.05.00	Routine checking to observe compliance to degree of protection, first numeral, on switchboard enclosures and busbar chambers shall be as under :			
	1) IP -4 X	It shall not be possible to insert a one mm dia. Steel wire into the enclosure from any direction, without using force.		
	2) IP-5X	It shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
15.00.00	ERECTION / INSTALLATION OF SWITCHBOARDS AND OTHER EQUIPMENTS			
16.00.00	COMMISSIONING OF LT SWITCHGEARS			
	Commissioning of LT switchgears at site shall only be carried out either by the switchgear manufacturer himself or under the supervision of the switchgear manufacturer.			
17.00.00	RESPONSIBILITY OF THE ASSOCIATE/COLLABORATOR (APPLICABLE IF LT SWITCHGEAR IS SUPPLIED THROUGH PROVENNESS CRITERIA: ROUTE-2):			
	The Associate/Collaborator (as applicable) for sourcing of LT Air Circuit Breaker shall be fully responsible and accountable for the item supplied and its compliance to the specification requirements.			
	The Associate/Collaborator (with respect to his manufactured and supplied LT Air Circuit Breaker) shall:			
	i) Participate in the Inspection of the LT Switchgears at Switchgear Supplier's Works, if required by Employer.			
	(ii) Participate in Technical Co-ordination Meetings (TCMs) from time to time during detailed engineering, if required.			
	(iii) Participate in Site Testing and Commissioning of LT Switchgears, if required.			
	(iv) Participate/address/resolve the issues raised during Contract Execution Period.			
18.00.00	Insulating Mat:			
	Insulating mat supplied for laying in front of LT Switchgears in switchgear rooms shall be as per IS:15652.			
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SUB-SECTION-B – 07

ESP ELECTRICAL PORTION



CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<u>ESP ELECTRICAL PORTION</u>			
1.00.00	GENERAL			
1.01.00	This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A"			
1.02.00	Technical requirements of ESP Electrical equipment like cables, ACP/MCC etc., which are not covered in the following clauses, shall be as described in relevant chapters of "Technical requirements (Electrical systems)" subsection.			
2.00.00	TRANSFORMER RECTIFIER SETS			
2.01.00	Codes and Standards Transformers shall conform to IS:2026/IEC60076. All other equipment/ accessories shall conform to relevant Indian Standards. Equipment conforming to equivalent International Standard like IEC shall also be acceptable. The transformer oil shall meet the fire safety requirement specified in paragraph 450-23 of National Electrical Code.			
2.02.00	Equipment Description a) Type Silicon oil (or any other oil with better properties) filled Single phase or Three phase High voltage transformer-rectifier (HVTR) set or Switch Mode High/Medium Frequency Transformer Rectifier set with HV disconnect ground switch for each section of the ESP field. The sets shall be mounted on top of precipitator. b) Tank Welded type construction. Tank cover shall be sloped to prevent retention of water. Shall be provided with bi-directional skids, lifting lugs and four jacking pads. c) CoreHigh grade non aging cold rolled grain-oriented silicon sheet steel laminations / Ferrite material for Transformer Rectifier d) WindingElectrolytic grade copper. e) Oil/ Oil preservation: The transformer oil shall be nontoxic and shall have high flash point (above 300 deg.C). Sealed type construction without breather. f) LT ConnectionCable : Degree of protection of cable box IP:54. g) Bushingsshall of Porcelain type. h) Marshalling box: Degree of protection IP-54, provided with thermostatically controlled space heaters. i) Protection: The enclosure of the Switch Mode Power Supply shall have a protection of IP 56 with provision for a space heater if required. j) Each TR set controller panel shall have isolating switch, power contactor, thermal overload relay, fuses for protection of SCRs etc.			
2.03.00	Fittings a) Temperature IndicatorDial type oil temperature indicators with alarm and trip contacts. b) Drip TrayShall contain total volume of cooling fluid. Drip trays shall be connected to a separator chamber through drainpipes. c) The separator chamber located at ground level shall be sized to contain oil from drainage of any two TR sets.			
2.04.00	Field Devices: a) Pressure Relief: Shall be of spring-loaded type, Minimum one number. b) Oil level indicator: Shall be ofMagnetic with low level alarm contact. c) Oil level gauge: Prismatic/ toughened glass. d) Buchholzrelay: shall be of double float type with Alarm and Trip contacts.			
2.05.00	Operating Conditions			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
3.00.00	a) Operation of precipitator shall not be affected when one rectifier unit is taken out of service. b) Flux density should not exceed 1.9 Wb/ sq.m. in the entire voltage variation range. c) V/F shall be designed for 1.1 continuous. d) Noise Level shall not exceed values specified in NEMA-TR-1/ IEC 60076 Part-10. e) Protection Suitability for working under transient sparking conditions & occasional short circuit load. Protection against surge, excess temp. rise & under voltage to be provided. f) Max. Temperature rise of oil : 50 deg.c above ambient 50 deg.c				
	ESP INSULATORS				
	a) High voltage insulator shall be located outside the gas stream, suitably housed in the insulator compartments to facilitate maintenance. Each insulator compartment shall be provided with insulator heaters or hot air ventilation system to avoid moisture condensation on insulators. In case of hot air system, it shall include fans, air filters, heaters etc. b) The insulator compartment shall be provided with thermal insulation. The compartment shall be designed such as to prevent ingress of flue gas into compartments. c) Insulators for supporting emitting frame and roof bushing shall be of porcelain suitable for long life, in ESP internal environment (highly polluted with flue gas temp. of 200 deg. C and going upto 300 deg. C for 5 minutes). Insulators and disconnecting switch shall be suitable for AC rms one minute dry power frequency withstand voltage level and lightning impulse voltage level as indicated at cl no. 6.01.05 of this sub section.				
4.00.00	ESP EARTHING SHIELDING & SAFETY INTERLOCKS				
4.01.00	Earthing & Shielding				
4.02.00	a) A complete earthing system with double path to the ground for all equipment and ESP structure shall be furnished. Each casing shall be provided with two earthing pads located on diagonally opposite corners of each casing. The pad surfaces shall be tinned, drilled and shall be connected to earthing mat by 50x6 galvanised steel flats. b) Manual safety earthing switches shall be furnished so that individual equipment can be grounded during maintenance. All access doors, gas distribution baffles or perforated plates located in the inlet or outlet nozzles of the precipitators shall have ground straps connected to the precipitators casing if they are not welded permanently to the casing. c) In case special earthing requirement is needed for electronic cabinets the same shall be furnished by the Bidder.				
	Safety Interlocks				
	a) Contractor shall provide a full proof manual key sequence type interlock system for the safety of operating personnel from contacting energised high voltage equipment. Key interlocks shall be provided such that for a particular ESP casing any TR set cannot be energised until all insulator housing compartments, disconnect switch boxes, casing inspection doors are locked and emitting and collecting electrode rapping motors are prevented from energisation. Also it shall prevent opening of any inspection door unless all TR sets of that stream are de-energised and all HV disconnect switches are opened to earthed position. Rapping motors operation shall be prevented under this condition unless interlock is specifically defeated for testing. b) Key interlock system shall be simple, robust, weather proof in construction suitable for outdoor mounting and positive in action. It shall be suitable for high degree of repeatability without wearing out.				
5.00.00	ESP CONTROL SYSTEM				
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.01.00	The control system shall be designed for automatic as well as manual local/remote operation. ESPs serving one boiler shall be provided with a complete control system consisting of microprocessor based EPMS, T/R set controllers, rapper controllers, communication controllers, hopper heater controls, insulator heaters and pressurization system controls and all other controls required for safe, efficient and reliable operation. Electrostatic Precipitator Management System (EPMS) The EPMS shall be connected to the Transformer Rectifier Set Controllers (TRC) / Switch Mode Power Supply and Rapper Controllers (RPC) through duplicate data highway. However, Contractor's standard, proven system of communication through balanced current loop is also acceptable. EPMS shall accept the feed back analog signals like Boiler Load Index, Output from opacity monitors and/or any other signals. EPMS shall process these signals and issue control parameters to the TR Controllers and Rapper Controllers as per bidder's standard proven practice. It shall also control, monitor and display the status of each stream i.e. status of TR Controllers, Rapper Controllers, hopper levels, insulator heaters/pressurization air blowers etc. Hopper/Insulators heater control achieved through suitable thermostats is also acceptable. The EPMS shall include, but not be limited to, the following features: a) A PC based master controller with non-volatile memory and report storage capabilities for a period of 6 months. b) TR set controllers and Rapper Controllers. c) High resolution minimum 20" colour flat TFT monitor. d) Communication ports and protocol for data transfer between EPMS Master control unit and the TRC/RPC/other controllers. e) Keyboard for operator interface. f) Color laser printer for alarms and reports g) Facility for Auto operation of ESP with Energy Management h) Necessary Input/Output points for interfacing with distributed digital controls and Management information system (DDCMIS). i) Self-surveillance and self-diagnostic features. The EPMS display unit shall display at least the following: a) A summary of the status of all the controllers. b) A summary of the readings of all the TR sets. c) A summary about each TRC i.e., settings, limits, voltage and current readings, alarms and the controller status. d) A summary of each RPC i.e. controller status, rapping frequency, alarms and indication of the rapper being operated. e) Status reading Energy Management System such as charge ratio of each field etc. f) Necessary alarms as decided during detail engineering stage. g) Status of hopper level, hopper heaters and insulator heater/blower (Preferably) h) ESP TR set power supply status and alarm i) Potential free contact for ESP trouble shooting etc. as required shall be provided. (If applicable) The PC based master controller i.e. operating and monitoring station together with high resolution minimum 20" size color flat TFT monitor, keyboard and colorlaser printer shall be located in the unit control & equipment room/ programmer's room for each unit.			
5.02.00	Microprocessor Based Transformer - Rectifier (T/R) set controllers / Switch Mode Power Supply (SMPS) :			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.03.00	Each Transformer rectifier set shall be provided with a separate microprocessor-based controller (TRC) for regulation and control of the electric power input to electrostatic precipitator fields. The EPROM shall be designed to obtain charge ratios minimum 1:99. It shall automatically optimize the charge ratio and maintain the spark rate at a suitable level for variations of gas temperature, dust composition, gas flow etc. It shall regulate the rectifier in such a way, that the current through the electrostatic precipitator is corrected as the conditions for sparking are changed. It shall be able to monitor filter functioning and shall give an alarm when values are lower or higher than set. It shall automatically regulate the charge ratio of each field/TR set based on V-I characteristics of the respective electrical fields. It shall have alternative arrangement of optimizing the charge ratio based on Opacity Monitor signal Also. The controller shall have proven noise immunity and shall be suitable for ESP application. It shall be capable of maintaining the optimum voltage and current in ESP under all regimes of boiler operation. TR set controller panel shall have gland plate of 4 mm thick of non-magnetic material. The system shall have the following features (but not limited to) : (a) Display unit for: (i) All the operating values like field DC voltages and currents. (ii) Spark rate (iii) Semi pulse current limit (iv) Voltage low limit (v) Charge ratio (vi) All other adjustable parameters & limits (b) Keys for operator interface and potentiometers local control and adjustments. (c) Serial communication with protocol for communicating to EPMS. (d) Local/ Remote selection. (e) Spark counter. (f) Alarms as mentioned below i) T/R set oil level low. ii) T/R set temperature high. iii) AC current high. iv) Low DC voltage. v) High DC voltage. vi) Back corona. (If applicable) vii) Management command failure. viii) TR set Buchholz / PRV trip ix) TR set Buchholz alarm			
	Microprocessor based Rapper Controller (RPC) Each stream of ESP shall be provided with a separate, Microprocessor based Rapper Controller (RPC). However, bidder's field proven standard design of rapper controller integral to TR set controller is also acceptable. It shall have proven noise immunity and shall be suitable for ESP application. It shall control the sequence and frequency of operation of the rapping mechanisms of collecting and discharge electrodes of the different			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
5.04.00	fields of the precipitator. The unit shall control and survey the operation of rappers in the ESP. It shall start and stop the rappers as programmed and shall give an alarm if a rapper fails. From the controller it shall be possible to start or stop manually each rapper, without interfering with the other rappers. The operation status of each rapper shall be indicated with LEDs on the rapper controller panel. It shall be possible to change the three timings (viz. start time, repetition time and run time), intensity (if applicable) and frequency of rapping independently for each rapper, without need for opening the panel or any alternation in programme. The range of rapping frequency available shall be up to 24 hrs. Additionally the rapper controller shall have at least fifty (50) nos. preprogrammed sequences of rapping stored in its memory so that the operator can select any of them according to his judgement or the controller itself can choose them based on feedback from boiler load. Alternatively bidder standard proven no's of pre programmers sequences of rapping shall also be acceptable. In case one separate rapper controller is provided for each stream, one standby working rapper controller shall be provided so that in case of failure of any one of the working rapper controllers, the standby controller shall immediately and automatically take over the control functions of this rapping without affecting the operation of ESP. The system shall have the following features (but not limited to): - Display of all adjustable parameters, rapping modes, time settings and intensity of rapper/ group and rapper status, rapper alarm and controller alarms. - Key board for operator interface. - Local/ remote selection: In local mode all commands and adjustments shall be from RPC. In remote mode all commands and adjustments shall be from EPMS. - Communication port with protocol for communicating with EPMS. - Remote on/ off capability from EPMS. - The controller address (field programmable), logic programmes and other adjustable parameters shall be stored in non-volatile memory and shall not be affected by power loss. Hopper Heater Control system Any one of the following methodology for control and monitoring of the hopper heaters shall be adopted: - The hopper heaters shall preferably be controlled and monitored from EPMS. The status of each hopper heater / set of heaters meant for a hopper shall be displayed on the EPMS unit. - Hopper heater control may be achieved through suitable thermostat. The status of each hopper heater / set of heaters meant for a hopper shall be displayed on the EPMS unit. - The hopper heater temperature can also be controlled and monitored using wireless technology employing local panels in ESP area and Hopper heater controller in a panel provided in ACP/ESP MCC room. Hopper heater controller with Data Acquisition system (DAS) shall communicate with local panels through wireless technology. The status of heater ON/OFF and healthiness shall be available in Local or Remote panels.		
6.00.00	TYPE TESTS		
6.01.00	List of Type Tests to be Conducted		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.01.01	a) TR set 1) Temperature rise test at rated DC current at 1:1 charge ratio 2) Lightning Impulse voltage test 3) Measurement of harmonic current in no load current 4) PRD operation test 5) Short circuit test (To be conducted as described below) This short circuit test shall be performed on TR set along with the TR panel and controller with a spark gap connected across the output. The gap is adjusted to get the spark at required peak voltage which is the short circuit condition and the controller will control the voltage to quench the spark. 6) Vacuum test on tank 7) Pressure test on tank 8) Induced over voltage test 9) Measurement of no load losses and current 10) Measurement of impedance voltage/ short circuit Impedance and losses 11) Measurement of IR 12) Measurement of acoustic sound level 13) Degree of protection test 14) Measurement of capacitance and tan delta			
	b) Insulators 1) Compression test on support insulator 2) Torsion test on shaft insulator 3) Lightning impulse test and one-minute dry power frequency test on each type of insulators. For 400mm Electrode spacing ESP field - Lightning impulse test voltage shall be 250KVp (negative) and one-minute dry power frequency test voltage shall be 95KVrms			
	c) Disconnecting switch 1) Lightning impulse test and one-minute dry power frequency test For 400mm Electrode spacing ESP field - Lightning impulse test voltage shall be 250KVp (negative) and one-minute dry power frequency test voltage shall be 95KVrms			
	d) Switch Mode Power Supply / TR set controller 1) Temperature rise 2) Measurement of line current harmonics			
	List of Type Tests for Which Reports have to be Submitted a) Switch Mode Power Supply / TR set controller 1) Degree of protection. 2) Dry heat test as per IEC-68-2-2 or equivalent for electronic modules 3) Damp heat test as per IEC-68-2-3 or equivalent for electronic modules			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
6.01.02	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.		
6.01.03	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet		
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SUB-SECTION-B – 08

HT LT & CONTROL CABLES

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00	<u>HT, LT Power Cables & Control Cables</u>			
	This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A".			
	CODES AND STANDARDS			
	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes :			
	IS:7098 (Part -II)	Specification for Cross linked polyethylene insulated PVC sheathed cables. Part-II: For working voltages from 3.3 KV upto and including 33 KV.		
	IS : 3975	Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.		
	IS:4905	Methods for random sampling.		
	IS : 5831	PVC insulation and sheath of electrical cables.		
	IS : 8130	Conductors for insulated electrical cables and flexible cords.		
	IS : 10418	Specification for drums for electric cables.		
	IS : 10810	Methods of tests for cables.		
	ASTM-D - 2843	Standard test method for density of smoke from the burning or decomposition of plastics.		
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.			
IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.			
IS : 3961 IEC- 332	Recommended current ratings for cables Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).			
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.			
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2.01.00	All cables (HT Power, LT power and control cables) shall be Armoured type irrespective of anything contrary mentioned elsewhere in the specification.
2.02.00	All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.
2.03.00	Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
2.04.00	XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.
2.05.00	The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmored cables, shall have distinct extruded PVC inner sheath of black color as per IS: 5831.
2.06.00	For single core Armoured cables, armoring shall be of aluminum wires. For multicore Armoured cables armoring shall be of galvanized steel as follows : -

Calculated nominal diameter of cable under armour		Size and Type of armour
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv)	Above 40 & upto 55mm	1.4 mm thick GS formed wire/2.5mm dia GS wire
v)	Above 55 & upto 70mm	1.4 mm thick GS formed wire/3.15mm dia GS wire
vi)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

2.06.03	Distinct extruded PVC inner sheath of black color as per IS:5831 shall be provided for the cables as follows:

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2.07.00	a) For all multicore cables. b) For single core Armoured cables, where armouring is not being used as metallic screen. Outer sheath shall be of PVC black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties. a) Oxygen index of min. 29 (Test method as per IS 10810 Part-58) b) Acid gas emission of max. 20% as per IEC-754 (Part-I) c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM-D-2843.			
2.08.00	Allowable tolerances on the overall diameter of the cables shall be +\ -2 mm maximum over the declared value in the technical data sheets.			
2.09.00	Cable lengths shall be considered in such a way that straight through cable joints is avoided.			
2.010.00	For LT Power cables, Multi core shall be considered up to 300Sq.mm only. All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated. However, for cable sizes up to 120 sq.mm. both XLPE insulated & PVC insulated LT power cables are acceptable. For LT cables, Same cable sizes to be used for same type & rating of motor i.e if there are three drives for one application, all three-drive motor should be provided with same cables sizes. However due to layout constraints no of runs of same size cable may be increased.			
2.011.00	Cores of the cables shall be identified by coloring of insulation. Following color scheme shall be adopted: i. 1 core - Red, Black, Yellow or Blue ii. 2 core - Red & Black iii. 3 core - Red, Yellow & Blue iv. 4 core - Red, Yellow, Blue and Black			
2.012.00	For reduced neutral conductors, the core shall be black.			
2.013.00	In plant repairs to the cables shall not be accepted. Pimples, fisheye, blow holes etc. are not acceptable.			
2.014.00	The cross-sectional area of the metallic screen strip/tape/wires shall be considered in sizing calculations.			
2.015.00	The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%.			
3.00.00	CABLE SELECTION & SIZING			
3.00.01	Cables shall be sized based on the following considerations: a) Rated current of the equipment b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage c) Short circuit withstand capability			
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3.00.02	Derating Factors Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes: a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables. The bidder shall furnish detailed cable selection/sizing criteria for Employer’s approval.			
4.00.00	CONSTRUCTIONAL FEATURES			
4.00.01	19/33, 11/11 KV Grade Power Cables: Cables shall conform to IS 7098 Part-II. These cables shall be multi-stranded, compacted circular aluminum conductor, XLPE-insulated, metallic screened PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for 33/33 KV Cables shall be “dry curing / gas curing “. For 11 KV / 11kV voltage grade cables method of curing shall be dry curing / gas curing / steam curing.The metallic screen for each core shall be capable of carrying the system earth fault current and shall consist of copper wires or tape with minimum overlap of 20%. However, for single core Armoured cables, the armouring shall constitute the metallic part of the screening.			
4.00.02	3.3/3.3kV Grade Power Cables: Cables shall conform to IS: 7098 Part - II. These cables shall be multi- stranded, compacted circular aluminum conductor, XLPE insulated, metallic screened, PVC outer sheathed. The metallic screen of each core shall consist of copper wires or tape with minimum overlap of 20%. However, for single core Armoured cables, the armouring shall constitute the metallic part of the screening. The metallic screen of each core shall be capable of carrying the system earth fault current. Method of curing for cables shall be "dry curing / gas curing / steam curing".			
4.00.03	Trailing Cables: Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968			
4.00.04	1.1 KV Grade Power Cables (a) 1.1 KV grade XLPE power cables shall have compacted aluminum conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armoured-PVC outer-sheathed conforming to IS: 7098. (Part-I). (b) 1.1KV grade PVC power cables shall have aluminum conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) Armoured, PVC outer-sheathed conforming to IS:1554 (Part-I).			
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4.00.05	(c) 1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968.															
	CABLE DRUMS															
	a) Cables shall be supplied in steel drums of heavy construction. The drum shall be designed on the basis of weight, diameter, bending radius and length of cable. The surface of the drum and the outer most cable layer shall be covered with waterproof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection.															
	b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing 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.															
5.00.00	c) The standard drum length for HT power cables with a maximum tolerance of +/- 5%, may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter for single core cable, and 750 meter for multicore cable.															
	d) The standard drum length of LT power cable with a maximum tolerance of +/- 5% may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter for single core cable excluding 630 sq.m size, and 750 meter for multicore cable & single core 630 sq.m.															
	e) The standard drum length for Control cables with a maximum tolerance of +/- 5% may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter.															
	f) One drum length of each cable size can be of non-standard length (not less than 250 meter) so as to match the ordered quantity subject to condition that there shall not be any joint in cable.															
5.01.00	TYPE, ROUTINE AND ACCEPTANCE TESTS															
	Type Tests															
	The reports for the following type tests shall be submitted for one size each of LT XLPE, LT PVC Power and control cables. The following type tests shall be carried out on one size each of 19/33 KV & 11/11 KV, 3.3/3.3 KV HT Cables. Size shall be decided by the employer during detailed engineering															
	<table><tr><td>S. No</td><td>Type Test</td><td>Remarks</td></tr><tr><td colspan="3">Conductor</td></tr><tr><td>1.</td><td>Resistance test</td><td></td></tr><tr><td colspan="3">For Armour Wires / Formed Wires</td></tr></table>				S. No	Type Test	Remarks	Conductor			1.	Resistance test		For Armour Wires / Formed Wires		
S. No	Type Test	Remarks														
Conductor																
1.	Resistance test															
For Armour Wires / Formed Wires																
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S. No	Type Test	Remarks
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wires only
6.	Wrapping test	
7.	Resistance test	
8(a)	Mass & uniformity of Zinc Coating tests	For GS wires/formed wires only.
8(b)	Adhesion test	For GS wires/formed wires only
	For XLPE insulation & PVC Sheath	
9.	Test for thickness	
10.	Tensile strength and elongation test before ageing and after ageing	
11.	Ageing in air oven	
12.	Loss of mass test	For PVC outer sheath only.
13.	Hot deformation test	For PVC outer sheath only.
14.	Heat shock test	For PVC outer sheath only
15.	Shrinkage test	
16.	Thermal stability test	For PVC outer sheath only
17.	Hot set test	For XLPE insulation only
18.	Water absorption test	For XLPE insulation only
19.	Oxygen index test	For PVC outer sheath only
20.	Smoke density test	For PVC outer sheath only
21.	Acid gas generation test	For PVC outer sheath only
22.	Flammability test as per IEC-332 Part-3 (Category -B)	For completed cable only

5.02.00

The following type tests reports for HT Cables shall be submitted for each type (voltage grade) & size of the cable:

S. No.	Type Test For all cables
1.	Insulation resistance test (Volume Resistivity method)
2.	High voltage test
For cables of 19/33kV, 11/11KV, 3.3/3.3KV Grade only.	
3.	Partial discharge test
4.	Bending test



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5.	Dielectric power factor test	
	a)	As a function of voltage
	b)	As a function of temperature
6.	Heating cycle test	
7.	Impulse withstand test	

Indicative list of tests/ checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of H.T. Cables enclosed.



SUB-SECTION-B – 09

DG SETS

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00	DIESEL GENERATORS			
	CODES AND STANDARDS			
	DIESEL ENGINE	IS -10000, BS- 5514		
	INTERNAL COMBUSTION ENGINES (12 PARTS)	IS -10000		
	SPEED OF DIESEL GENERATOR	BS649 / 195B		
	ALTERNATOR	IS-4722/IEC-60034, IS12065, IS12075		
	PERMISSIBLE LIMITS OF NOISE LEVEL OF ROTATING MACHINES	IS 12065		
	MEASURE, EVALUATION AND LIMIT OF VIBRATION SEVERITY OF ROTATING ELECTRICAL MACHINES SHAFT 65 mm DIA OR HIGHER	IS 12075		
	DIESEL FUELS – SPECIFICATIONS	IS1460		
	RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL	IS 2629		
	METHODS FOR TESTING UNIFORMITY OF COATING OF ZINC COATED ARTICLES	IS 2633		
	CODE OF PRACTICE FOR FIRE – SAFETY	IS 3034		
	RECIPROCATING INTERNAL COMBUSTION ENGINES	ISO 3046, ISO 15550		
	OSID STANDARD ON LIGHTENING PROTECTION	OISD-GDN-180		
1.01.00	The installation work shall conform to Indian Electricity Act and Indian Electricity Rules as amended up to the date this specification is issued. Any approval required from statutory authorities shall be obtained by the Contractor. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.			
1.02.00	Equipment complying with other internationally accepted standards such as ASA, IEC, BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent to or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted and also furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments in force as on date of opening of bid. Bidder shall clearly bring out the salient features for comparison.			
2.00.00	TYPE			
	Diesel Engine	Stationary type, turbo charged and water cooled.		
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3.00.00	TECHNICAL REQUIREMENTS		
	a)	Ambient temperature	50 degree. (to be considered for deration of alternator)
	b)	Relative Humidity	100%
	c)	Fuel	HSD Fuel as per IS 1460
	d)	Rated Speed	1500 rpm
	e)	Governor (Electronic Type)	A1 type as per BS:5514
	f)	Vibrations	Max. 250 microns peak to peak with anti-vibration pads
	g)	Starting	Electrical self starting
	h)	Fuel service tank	990 litres
	i)	Air intake system	Dry type air filter, 15 micron size or better with 90% efficiency or better
	j)	Cooling	Forced water cooled for Engine & Air cooled for Alternator.
	k)	Paint Shade	Grey RAL9002
4.00.00	GENERAL		
4.01.00	The sizing criteria for the emergency DG set is given in General electrical requirement in General Specification.		
4.02.00	The emergency DG set shall come in to operation in the event of total power failure in the station.		
4.03.00	DG set including stack height, acoustics, air emission and fuel oil installation shall meet the requirement given by gazette notifications of Ministry of Environment & Forest time to time , CPCB guidelines, all statutory requirement of Govt. of India and State Pollution Board Guidelines & as updated as on date of bid opening. Necessary lightening protection shall be provided by the bidder for the stack as per statutory and safety requirements. Bidder shall furnish the detailed break-up for arriving at the capacity of the DG set and also furnish overload capacity with a variation in ambient temperature.		
4.04.00	DG Set shall be located inside acoustic enclosure and suitable for outdoor duty. The bidder shall recommend his own layout and indicate the space requirement. If required, the necessary approval of the installation from statutory authorities shall be taken by bidder. The exhaust shall be discharged through a silencer & stack at a sufficient height. Necessary lightning protection as per OISD standard OISD-GDN-180 shall be provided by the bidder for the stack		
4.05.00	The generating set shall be suitable placed and enclosed so as to meet the technical, functional and statutory requirement like Noise level, IP protection etc.		
4.06.00	Critical speed of the machine shall not be lesser than 120% of the normal speed.		
4.07.00	All couplings shall be capable of withstanding the maximum generator sudden short circuit torque.		
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4.08.00	Necessary ducting, piping, valves, drains, etc. shall also be provided.			
4.09.00	Maintenance and erection tools and tackles for all the equipment shall be provided by the bidder.			
4.10.00	The DG set shall be capable of starting largest size of emergency 415 V drive (motor) having starting KVA/rated KW ratio of 8 (higher if starting current is more than 8) and starting power factor of 0.2 with terminal voltage drop being restricted to 15%. Generator loading before starting of this motor shall be considered as 50% of generator rating. However, actual motor parameters may be used if available.			
4.12.00	The DG set shall also be able suitable for 12 hours continuous running of which one hour at 10% overload at rated speed.			
4.11.00	BHP rating of the engine shall be Limited-time running Power (LTP) as per ISO 8528-1 considering deration for 50 deg C ambient temperature			
4.13.00	The DG set shall be able to deliver specified net electrical out put while supplying power / driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft.			
5.00.00	DUCTING, PIPING VALVES AND FITTINGS			
5.01.00	The engine shall be supplied with all necessary silencer, exhaust, piping, valves and fittings for the fuel oil, lubricating oil, engine starting, air inlet and engine exhaust system, along with expansion joints, drain plugs, flanges and their support structure etc.			
5.02.00	Necessary starters for ventilation fans/ exhaust fans / acoustic enclosure and priming pump motors etc. shall be in the scope along with necessary AC distribution board, cables and cabling. Distribution board shall be metal enclosed, compartmentalized, wall/structure mounted and shall be fabricated out of cold rolled sheet steel of thickness 1.6mm with degree of protection of IP-54. The same shall be provided inside the acoustic enclosure. The alternator outgoing supply of DG Set shall be fed into bidder's breaker panel.			
6.00.00	OPERATIONAL REQUIREMENTS			
6.01.00	Starting and Control.			
6.01.01	All DG Sets shall be controlled independently through separate control panel. It shall also have auto initiation through a 'No volt relay 'and' Auto position of auto/manual selector switch. Subsequent loading of the set shall also be automatic up to a preset value. It shall also have auto initiation through command from remote panel/ central control room. The DG set shall have suitable control arrangement so as to meet functional/control requirement mentioned elsewhere in the specification. Necessary relays, contactor etc for the purpose shall be included. Also three (3) attempt starting facility shall be provided.			
6.01.02	The starting time required from the initiating signal until the operating speed and voltage is attained and the engine and generator are ready to take load, shall not be greater than 30 seconds. Three attempt starting facility shall be provided either by using two impulse timer and a summation timer or by using microprocessor based controller along with auxiliary panel if any. The DG set shall lockout automatically in case of failure of above. The DG shall			
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	be capable of being stopped manually from remote as well as local. Interlock shall be provided in DG control panel to prevent shutting down operation (when in auto mode) as long as the circuit at generator output is closed. 6.01.03 For electrical self starting system the source of energy shall be batteries backed up by battery chargers which shall be supplied 6.01.04 The starter motor shall conform to IS: 4722. 6.01.05 The fuel oil system and the lubricating oil shall also start operating simultaneously and automatically as soon as a starting impulse is received to obviate any chance of seizure of the piston and bearing as well as air locking in fuel supply system. 6.02.00 Battery and Battery Charger 6.02.01 The battery for starting the engine shall be capable of performing six (6) normal start without recharging The charger shall be protected by a suitable current limiting device. The battery shall be sized for site minimum temperature. Battery and battery charger shall also feed the control supply of DG control panel. The minimum voltage at the end of load cycle shall not be less than 1.75 volts per cell. 6.02.02 A suitable battery charger shall be housed inside the panel to recharge the battery within ten hours. The battery charger shall be SMPS based automatic and shall be complete with the following a. DC voltmeter b. DC Ammeter c. Float / Boost selector switch Auto / Manual selector switch for Boost to float change over. d. The charger shall have necessary filters to reduce the ripple factor less than three (3) and suitable dropping characteristics by means of choke and/ or suitable input transformer impedance to automatically reduce the charging current as the battery gradually charges up 6.02.03 The battery shall be of at least 24V 360 AH or 2 sets of 2 numbers of 12 V, 180 AH battery connected in parallel and shall conform to the requirements of IS : 7372 /IEC:60095. The battery with Polypropylene containers meeting the other technical requirements of IS: 7372 may be acceptable 7.00.00 DIESEL GENERATOR CONTROL PANEL 7.01.01 The local control panel shall be of robust construction, floor mounting, free standing type made of 2.0 mm thick CRCA sheet steel including doors and Partition. Neoprene gaskets shall be provided between all openings and joints. It shall be provided with hinged door with locking arrangement. The control panels shall have IP-54 degree of protection as per IS: 13947 Part-I. Control panel with provision for local starting shall be provided. This shall incorporate all controls required for starting, monitoring, regulating and stopping DG set. It shall be equipped with all necessary instrumentation to provide adequate surveillance of DG set under all operating conditions including ‘Standby’. All cables shall be bottom entry. Enough space shall be provided in the control panel for easy access during maintenance and repairs. A tinned copper/ aluminum bus-bar of adequate dimension shall be provided for earth connection complete with nuts and bolts as required for external connection to earth grid.			
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7.02.00	CT shorting links, test terminal blocks etc. shall be provided. All the equipment mounted inside the control panel shall be identified by lamicoid labels/ stenciling by paint. Panel shall be provided with panel illumination lamp operated by the door switch and thermostat-controlled space heater. Control panel shall be furnished complete with all accessories and wiring for safe and trouble free operation of the system.			
	The Control panel shall be complete with the following (i) Microprocessor base control unit Microprocessor base control unit with following. (a.) Voltage sensing mains supply failure monitor (b.) Auto engine start / stop & failure to start lock out. (c.) Generator voltage & frequency sensing (d.) Selector switch and push button to facilitate remote starting/stopping, speed & voltage control (e.) Manual / Auto / Test selector switches (f.) DG start /stop push button (g.) DG Incomer Breaker close / trip push button (h.) Mains breaker close / trip push button (i.) Auto manual Speed adjustment (j.) Auto manual Voltage adjustment (k.) Auto manual selector switch for priming pump motor (if required) (ii) LED indication lamps LED indication lamp shall be provided for the following (a.) 'DG ON' indication lamp' (b.) DG Breaker ON' indication lamp (c.) 'Mains ON' indication lamp (d.) 'Mains Breaker ON' indication lamp. (e.) Charger ON indication lamp. (iii) Annunciation Annunciation for the following shall be provided with fault indication, alarm & trip contact, accept, reset and test facility. Any one or more of the following defects shall cause the alarm or running diesel generator to be tripped. In case of tripping, re-start shall be prevented until the fault(s) are removed and manual resetting is done. Separate indicators shall be provided for each of the following in control panel: (a.) Engine fails to start(Alarm) (b.) Low lube – oil pressure.(Trip) (c.) High cooling water temperature.(Trip) (d.) D.G. overload.(Alarm)			
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	(e.) DC failure (f.) DG over speed(Trip) (g.) Fuel level low in0 day tank(Alarm) (h.) Fuel level very low in day tank(Trip). (i.) Generator stator temperature high.(Alarm) (j.) Electrical protection operated.(Trip) (k.) Incomer to emergency switchgear from DG closed. (l.) Earth fault (alarm) input from switchgear. (m.) Lube Oil Priming Pump 'Fault' indication (if applicable) (iv) Metering Following meters shall be provided in the panel: (a.) AC voltmeter (b.) AC Ammeter (c.) Frequency meter (d.) Electronic Kwh meter with counter display. (e.) KW meter (f.) PF Meter			
7.03.00	Suitable 4-20mA transducers with dual output shall be provided in the control panel for voltmeter & frequency meter readings at remote use.			
7.04.00	In addition, coupling relays (with diodes) having 24V DC or suitable energizing coil in the control panel shall be provided for remote application for the followings (a.) DG Start (b.) DG Stop (c.) DG Voltage raise (d.) DG voltage lower (e.) DG speed raise (f.) DG speed lower (g.) DG auto start			
7.05.00	For issuing simultaneous start command to standby DG set, there shall be set of three (3) aforesaid coupling relays in case of standby DG set. Provision for following status/ signal shall also be provided in the DG control panel: (a.) DG fail to start. (b.) DG start command actuated/ reset. (c.) DG working/ stop signal. (d.) DG trouble/ normal signal.			
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	(e.) DG control supply failure/ normal signal. 7.06.00 The requirement of CT, VTs, relays, timers, auxiliary contacts shall be as per the system requirement. 7.07.00 The bidder shall supply any other controls and indications for diesel generator set though not specifically mentioned here but which the supplier may recommend and are required to make system complete for satisfactory operation of DG sets. 7.08.00 Necessary pressure switches, level switches, thermostats, flow switches, auxiliary relays, etc. required for the above alarm and annunciation system shall be furnished under the scope of this specification. 7.09.00 Panel shall be provided with panel illumination lamp operated by the door switch and thermostat-controlled space heater. Control panel shall be furnished complete with all accessories and wiring for safe and trouble free operation of the system 7.10.00 All fuses shall be of HRC cartridge link type. Screw type fuses are not acceptable 7.11.00 Relays 7.11.01 A voltage relay for sensing the supply to control Panel shall be provided. The relay shall operate at about 90% of voltage and shall be English Electric type VAG 11 or equivalent 7.12.00 Indicating lamps shall be of the panel mounting LED type with series resistor and of low power consumption. Lamps shall be provided with series resistor built-up lamp assembly 8.00.00 DIESEL ENGINE 8.01.00 Construction Features (a) Diesel engine shall be mounted on visco damper type vibration dampening system or equivalent anti-vibration mounting system (as recommended by Engine manufacturer) and shall be complete with integral air intake through dry type air filters and exhaust systems, metering facility, speed regulation system, fuel injection system, lube oil system, primary cooling water system along with necessary filters, silencers, ducts, exhaust, piping and fittings, valves, instruments, etc. as required. (b) The generating unit shall be complete with all auxiliaries and its performance, torsional vibration, materials and workmanship, etc. shall be in accordance with the standard practices of diesel engine manufacturer's association in USA. IS-10000, BS-5514. The engine shall be properly balanced so as to transmit only small unbalanced forces to the foundation. 8.02.00 DIESEL OIL SYSTEM (a) The diesel oil system as provided shall be complete with simplex type filters, hoses, piping, fittings, relief valves, supports, control and instrumentation and all other accessories to make it complete. (b) The fuel consumption of the engine at full and three quarters of its rated power output shall be indicated.			
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8.03.00	(c)	A day oil tank of 990 litres fuel capacity shall be provided, mounted on fabricated steel platform outside the acoustic enclosure. The tank shall be complete with level indicator marked in Litres, two nos. of level switches, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. All pipe joints shall be brazed/ welded.		
		Lubricating oil System		
	(a.)	Automatic pressure lubrication shall be provided by a shaft driven gear type pump through an oil cooler and fin mesh filters to the end bearing, camshaft bearings, camshaft chain and gear drives, governor, air starting, distribution, auxiliary drive gears etc.		
	(b.)	Hand driven and/ or A.C. motor driven lube oil priming pump (if applicable) along with starter is to be provided as recommended by the engine manufacturer.		
	(c.)	All necessary accessories like pressure gauges, temperature and oil level indicators, pressure relief valves, bypass valves, pressure switches for alarm and control shall be furnished together with all inter connecting piping, fittings, supports, valves, etc.		
	(d.)	A lubricating oil filter shall be provided for operation under normal conditions for period of a more than 250 hours without the necessity of its replacement or cleaning.		
8.04.00		Cooling System		
		In case, Jacket water cooling system is offered, same be in closed cycle and shall have radiator located in front of the engine with a fan driven mechanically from the engine shaft. Forced water circulation by means of pump driven by the engine shaft shall be employed. The radiator tubes shall be of copper with sufficient heat transfer area.		
8.05.00		Governing System		
	(a)	The governor shall be electronic type with class A1 type as per BS-5514.		
	(b)	The governor shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However a tripping shall be provided even if speed exceeds the maximum permissible limit.		
8.06.00		Ancillary Equipment		
		The following equipment as per system requirements shall be included:		
	(a.)	Flywheel		
	(b.)	Fuel piping		
	(c.)	RPM indicator		
	(d.)	Lubricating oil cooler		
	(e.)	Exhaust silencer and piping		
	(f.)	Fuel and lubricating oil filters, air filters.		
	(g.)	Temperature indicator for water.		
	(h.)	Pressure indicator for lubricating oil		
	(i.)	Hand barring gear.		
	(j.)	Necessary foundation bolts and base channels for the engine, alternator, fuel service tank and for all other equipment included in this package.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
9.00.00	(k.) Base frames (l.) Starting equipment (m.) Protective equipment preferably in the form of fuel cut-off solenoid and suitable relays to protect the engine against low lubrication pressure. (n.) Lifting attachment for lifting the complete set or the engine alternator separately. (o.) Radiator. (p) Any other ancillary equipment not specifically mentioned in the specification but are necessary for proper operation and maintenance of the set and safety of operating personnel.			
	GENERATOR i) The generator shall be of totally enclosed or screen protected drip proof and self air cooled type. The generator shall be driven by the Diesel engine in this specification and shall match the same in all respects. The generator shall conform to IEC-60034. ii) AC generator shall be supplied along with it's excitation system, AVR and include all necessary auxiliaries. iii) Rating The Generator shall be star connected 3-phase, 50 Hz synchronous generator and shall have a continuous rating. The operating condition for each electric generator shall be as follows: a) Voltage : 415V b) Frequency : 50 C/S (+3 to-5%) c) Power factor : 0.80 iv) Insulation and Temperature Rise of Windings and Core All insulated winding conductors of alternator shall be of copper. The generator stator and rotor windings core insulation and all connections including main and neutral leads shall have insulation conforming to IEC-60034-Pt1. The winding shall be given power house treatment (i.e. two coats of varnish and backing followed by final coat of resin). The total insulation shall be non hygroscopic. The temperature rise of the stator core and mechanical parts in contact with or adjacent to winding shall not exceed the specified limits of IEC-60034-Pt1. v) Space heaters Suitably rated 240 V, single phase, 50 Hz, space heaters located in lower part of alternator shall be provided to maintain the internal temperature above the dew point to prevent moisture condensation on the insulation when the set is not running. vi) Separate terminal boxes shall be provided for phase and neutral side of leads. The terminal boxes shall be dust tight, weather proof phase segregated double walled (metallic as well as insulated barriers) having degree of protection of IP-54 as per IS: 13947..			
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	vii) Elastimold terminals with protective covers shall also be acceptable. As far as possible connection between exciter and alternator shall be contained within the machine frame and connections carrying AC and DC current shall be segregated from each other. The necessary CT's for differential protection shall be provided on neutral side. viii) Alternator vibration level shall not exceed the values as defined in IS:12075. Alternators in case driven by Diesel engine shall be able to withstand vibration level of 9mm/sec. as per BS 5000 Part III. Vibration level shall not exceed the permissible levels for Generator however the same shall in any case not exceed 250 micron peak to peak. ix) Resistance element temperature detector shall be installed at the following locations: Six numbers of Duplex type or 12 nos. Simplex type Resistance element Temperature Detectors (RTDs) shall be suitably distributed at locations where highest temperatures may be expected in stator windings and one (1) element in each bearing. The RTD's shall comply with the latest edition of IS:2828. x) The generator shall be complete with voltage transformers necessary for AVR/ Synchronization. xi) The Main Phase side terminal box shall be suitable for terminating Sandwiched type LT bus ducts/cables. The sizing of the same shall be as per system requirements. xi) As far as possible connection between exciter and alternator shall be contained within the machine frame and connections carrying AC and DC current shall be segregated from each other. The necessary CT's for differential protection shall be provided on neutral side. The neutral point shall be brought to DG control panel and shall be connected to 300/110V VT, to be supplied and mounted inside the DG control panel by the bidder for earth fault detection.			
9.01.00	Excitation System			
	The generator shall be provided with complete excitation system capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant within +/- 1% of set value. The setting range available on voltage regulator shall be at any value with +/- 10% of the rated voltage. It shall be possible to set the same from remote also.			
9.02.00	TECHNICAL PARAMETERS OF CURRENT AND POTENTIAL TRANSFORMERS TO BE SUPPLIED BY THE BIDDER.			
9.02.01	Neutral side current transformers for differential protection:			
	(a.) Type	Cast resin, bar primary		
	(b.) Voltage	660V, 50Hz		
	(c.) Ratio	2500/1A		
	(d.) KPV	>= 125V		
	(e.) RCT	=< 3 ohm		
	(f.) Class	PS		
	(g.) One minute power frequency withstand voltage	2.5KV		
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
9.02.02	Single phase voltage Transformers (Neutral)			
	(a.) Type	Cast resin		
	(b.) Voltage Ratio	300/110		
	(c.) Accuracy	1.0 class		
	(d.) Rated Voltage factor	1.2 continuous		
	(e.) VA Burden	20VA		
	(f.) One minute power frequency withstand Voltage	2.5kV rms		
9.02.03	Voltage Transformers for Metering			
	(a.) Type	Cast resin		
	(b.) Voltage Ratio	440/110		
	(c.) Accuracy class	1.0		
	(d.) Rated Voltage factor	1.2 continuous		
	(e.) Burden	100VA		
	(f.) One minute power frequency withstand Voltage	2.5kV rms		
10.00.00	SOUND PROOFING SYSTEM			
10.01.00	Bidder shall furnish design calculation for sound proofing/ ventilation system. The detailed frequency response for noise absorbing characteristic of acoustic material shall be furnished.			
10.02.00	The sound absorptive layer shall comprise of bonded type mineral wool/glass wool of adequate thickness and density to comply the design requirements.			
10.03.00	DG shall be placed in acoustic enclosure. The requirements of acoustic enclosure are as following:			
	a. The acoustic enclosure shall be fabricated from 2.0 mm thick CRCA sheet with steel section & frame of suitable size. The construction shall be modular type to facilitate dismantling as required for maintenance. The frame shall be of sufficient stiffness and rigidity. The enclosure shall be suitable for outdoor duty. The sheet and all sections shall be powder coated shade of grey RAL9002. A minimum clear space of 800mm shall be kept inside the enclosure.			
	b. The exposed surface of lining shall be retained in place by minimum 1.0mm thick CRCA/ aluminium perforated sheet. Absorptive lining shall be provided between the perforated sheet and absorbing material. Necessary acoustic sealing shall be done in the panels/ modular unit joints.			
	c. Enclosure shall be provided with adequate lighting. Enclosure shall be provided with adequate number of door and viewing glass.			
	d. All hardware of mild steel shall be electro-galvanized.			
10.04.00	The door design shall be generally compatible to the enclosure design. The bonded mineral wool slab of adequate thickness shall be used. The door shall be provided with heavy duty hinges and handles. The sealing shall be done with neoprene/ silicon rubber gasket to avoid leakage of noise. The size of the door shall be as per the functional requirements.			
10.05.00	Suitable louvers with acoustic treatment shall be provided as required.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
10.06.00	Ventilation system of adequate capacity shall be provided. The system shall comprise of tubular axial flow fans for air intake and air exhaust with splitter silencer. The ventilation shall be design to ensure required air flow rate as per manufacturer recommendations, after providing necessary acoustic treatment/ silencers in air flow path. The ventilation system shall be design to prevent leakage of sound and temperature shall not increase by more than 5 degree centigrade when DG is running continuously at specified rating.			
10.07.00	The construction of ventilation duct shall be from 1.6 mm thick CRCA perforated sheet. Other constructional details shall be similar to that of the acoustic enclosure.			
10.08.00	The exhaust air from radiator shall be discharge through modular duct of adequate size.			
10.09.00	The acoustic enclosure shall have suitable opening for routing out of Sandwiched type LT bus ducts/cables from alternator terminal box. Further suitable acoustic treatment of the opening shall be done to achieve the desired acoustic level.			
10.10.00	Any other facility required to achieve the desired acoustic level shall be in the bidder's scope.			
11.00.00	TYPE TESTS			
11.02.00	Type test reports for the following type tests shall be submitted:			
11.02.01	Type test reports on Engine			
	This shall be as per ISO 3046/15550			
11.02.02	Type test reports on Alternator			
	(a.) Measurement of resistance			
	(b.) Phase sequence test			
	(c.) Regulation test			
	(d.) Measurement of open circuit and short circuit characteristics			
	(e.) Efficiency test			
	(f.) Temperature Rise Test			
	(g.) Momentary overload test			
	(h.) Over speed test			
	(i.) High Voltage test			
	(j.) Insulation resistance test (both before and after High Voltage Test)			
	(k.) Noise level as per IS:12065			
	(l.) Vibration as per IS: 12075.			
	(m.) Determination of Deviation of voltage waveform from sinusoidal.			
	(n.) Degree of protection test on control panel for IP-52			
12.00.00	COMMISSIONING CHECKS			
12.01.00	In addition to the checks and test recommended by the manufacturers, the contractor shall supervise the following commissioning test to be carried out on each set at site.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
12.01.01	The battery or compressed air system for starting the engine shall be capable of performing six (6) normal start without recharging.		
12.01.02	Load Test The engine shall be given test run for a period of at least 6 hours. The set shall be subjected to the maximum achievable load as decided by Project Manager without exceeding the specified DG set rating. During the load test half hourly records of the following be taken: (a.) Ambient temperature. (b.) Exhaust temp. if exhaust thermometer is fitted. (c.) Cooling water temp. at a convenient point adjacent to the water output from the engine jacket. (d.) Lubricating oil pressure. (e.) Speed. (f.) Voltage, wattage and current output. (g.) Oil tank level.		
12.01.03	Insulation Resistance Test for Alternator Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500 V megger shall not be less than $IR= 2x \text{ (rated voltage in KV) } + 1$.		
12.01.04	Check of fuel consumption A check of the fuel consumption shall be made throughout the load run test. The fuel consumption should not exceed the design values.		
12.01.05	Insulation Resistance of Wiring Insulation resistance of control panel wiring shall be checked with 500V megger. The IR shall not be less than one mega ohm.		
13.00.00	FUNCTIONAL TESTS Following functional tests are to be carried out at site:		
13.01.00	Functional tests on control panel.		
13.02.00	Functional tests on starting provision on the engine.		
13.03.00	Functional tests on all field devices.		
13.04.00	Functional tests on DG Set complete with AVR and speed governor.		
14.00.00	MEASUREMENT OF VIBRATION The vibration shall be measured at no load and at load as close to maximum achievable load and shall not exceed 250 microns. Any modification/rectification required to bring down the vibration level with in allowable limits specified by the manufacturer shall be done by the bidder. Vibration test is to be carried out at site.		
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SUB-SECTION-B – 10

CABLING EARTHING AND LIGHTNING PROTECTION

CLAUSE NO.	TECHNICAL REQUIREMENTS																																																							
1.00.00	CODES AND STANDARDS																																																							
1.01.00	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable . <table><tr><td>IS:513</td><td>Cold rolled low carbon steel sheets and strips.</td></tr><tr><td>IS:802</td><td>Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</td></tr><tr><td>IS:1079</td><td>Hot Rolled carbon steel sheet & strips</td></tr><tr><td>IS:1239</td><td>Mild steel tubes, tubulars and other wrought steel fittings</td></tr><tr><td>IS:1255</td><td>Code of practice for installation and maintenance of power cables upto and including 33 KV rating</td></tr><tr><td>IS:1367 Part-13</td><td>Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).</td></tr><tr><td>IS:2147</td><td>Degree of protection provided by enclosures for low voltage switchgear and control gear</td></tr><tr><td>IS:2309</td><td>Code of Practice for the protection of building and allied structures against lightning.</td></tr><tr><td>IS:2629</td><td>Recommended practice for hot dip galvanising of iron & steel</td></tr><tr><td>IS:2633</td><td>Method for testing uniformity of coating on zinc coated articles.</td></tr><tr><td>IS:3043</td><td>Code of practice for Earthing</td></tr><tr><td>IS:3063</td><td>Fasteners single coil rectangular section spring washers.</td></tr><tr><td>IS:6745</td><td>Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</td></tr><tr><td>IS:8308</td><td>Compression type tubular in- line connectors for aluminium conductors of insulated cables</td></tr><tr><td>IS:8309</td><td>Compression type tubular terminal ends for aluminium conductors of insulated cables.</td></tr><tr><td>IS:9537</td><td>Conduits for electrical installation.</td></tr><tr><td>IS:9595</td><td>Metal - arc welding of carbon and carbon manganese steels - recommendations.</td></tr><tr><td>IS:13573</td><td>Joints and terminations for polymeric cables.</td></tr><tr><td>BS:476</td><td>Fire tests on building materials and structures</td></tr><tr><td>IEEE:80</td><td>IEEE guide for safety in AC substation grounding</td></tr><tr><td>IEEE:142</td><td>Grounding of Industrial & commercial power systems</td></tr><tr><td>DIN 46267 (Part-II)</td><td>Non tension proof compression joints for Aluminium conductors.</td></tr><tr><td>DIN 46329</td><td>Cable lugs for compression connections, ring type ,for Aluminium conductors</td></tr><tr><td>BS:6121</td><td>Specification for mechanical Cable glands for elastomers and plastic insulated cables.</td></tr><tr><td></td><td>Indian Electricity Act.</td></tr><tr><td></td><td>Indian Electricity Rules.</td></tr></table>				IS:513	Cold rolled low carbon steel sheets and strips.	IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.	IS:1079	Hot Rolled carbon steel sheet & strips	IS:1239	Mild steel tubes, tubulars and other wrought steel fittings	IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating	IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).	IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear	IS:2309	Code of Practice for the protection of building and allied structures against lightning.	IS:2629	Recommended practice for hot dip galvanising of iron & steel	IS:2633	Method for testing uniformity of coating on zinc coated articles.	IS:3043	Code of practice for Earthing	IS:3063	Fasteners single coil rectangular section spring washers.	IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.	IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables	IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.	IS:9537	Conduits for electrical installation.	IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.	IS:13573	Joints and terminations for polymeric cables.	BS:476	Fire tests on building materials and structures	IEEE:80	IEEE guide for safety in AC substation grounding	IEEE:142	Grounding of Industrial & commercial power systems	DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.	DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors	BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.		Indian Electricity Act.		Indian Electricity Rules.
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1.02.00	Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.																																																							
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.00.00	DESIGN AND CONSTRUCTIONAL FEATURE			
2.01.00	Inter Plant Cabling			
2.01.01	Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route. Cables crossing Railway line (if applicable) shall be laid underground through nearest culvert. Necessary statutory clearance if required shall be taken by Bidder. All HT, LT and control cable shall be armoured.			
2.01.02	Transformer yard In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.			
2.01.03	Trenches PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.			
2.01.04	No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.			
2.01.05	Cable Vault The cable vault/ / cable spreader room space below the HT / LT switchgear room, Control Rooms, unit control equipment room, Programmer room, UPS, Charger & Battery Rooms, shall have 800 mm wide and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables Cable vaults shall be provided with adequate drainage facilities for drainage of fire water. Each cable vault should have at least two doors. Exit signs shall be provided near doors for personnel escape in case of emergency			
2.01.06	Boiler Area Cable trays in boiler & ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor. Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.			
2.01.07	Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.			
2.01.08	OffSite Area For feeder in bidder's scope for offsite areas, overhead cable tray arrangement shall be followed. However cable trenches/slit may also be acceptable, for some areas, if found to be required during detailed engineering. Cable trenches provided shall be separated from fuel oil area to avoid oil accumulation.			
2.01.09	The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.			
2.01.10	Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.01.11	Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to: - Meet all safety requirements - Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc			
3.00.00	EQUIPMENT DESCRIPTION			
3.01.00	Cable trays, Fittings & Accessories			
3.01.01	Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.			
3.01.02	Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.			
3.01.03	Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm. For field routing (like from instruments to JB, etc) 50mm /100mm trays will be provided as per requirement.			
3.01.04	Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.			
3.01.05	The tolerance for cable tray and accessories shall be as per IS 2102 (Part-1). Tolerance Class: - Coarse			
3.02.00	Support System for Cable Trays			
3.02.01	Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.			
3.02.02	Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc. b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanised. c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement			
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	bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation. e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below: The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079. f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position. g. Support system shall be able to withstand • weight of the cable trays • weight of the cables (75 Kg/Metre run of each cable tray) • Concentrated load of 75 Kg between every support span. • Factor of safety of minimum 1.5 shall be considered. 3.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid. 3.02.04 Four legged structure shall be provided wherever there is change in elevation and change in direction 3.02.05 FOR COAL HANDLING PLANT/FGD PLANT/ ESP AREA THE FOLLOWING SHALL ALSO BE APPLICABLE: a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route. b) Cable trenches shall be provided only in Switchgear/MCC rooms. c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc. d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.
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3.03.00	Pipes, Fittings & Accessories			
3.03.01	Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria			
3.03.02	GI Pipes shall be of medium duty as per IS: 1239			
3.03.03	Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.			
3.03.04	Hume pipes shall be NP3 type as per IS 458.			
3.03.05	TERNE Coated Flexible Steel Conduits shall be water proof and rust proof made of heat resistant lead coated steel. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes and lighting fixtures			
3.03.06	HDPE pipes and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 part-I.			
3.04.00	Junction Boxes			
3.04.01	Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:- (a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102 (b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb. (c) Class of protection shall be IP 55. (d) HV test.			
3.04.02	Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.			
3.05.00	Terminations & Straight Through Joints			
3.05.01	Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type			
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	test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless crimping type cable lugs & ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables.			
3.05.02	Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system & of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV & 3.3 KV system. Straight through joints shall have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design			
3.05.03	1.1 KV grade Straight Through Joint shall be of proven design.			
3.06.00	Cable glands			
3.06.01	Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.			
3.07.00	Cable lugs/ferrules			
3.07.01	Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections. Crimping tool for crimping (from 1.5sqmm cable to 630sqmm cables) above mentioned lugs shall be of Hexagonal Type crimp profile, with suitable die of crimp match code. Characteristics of crimping tool: 1) To should generate enough pressure to pass pull out test as per IEC 61238-1. Relevant type test to be produced for the sizes specified in the tender. 2) Tool die shall be replaceable for assorted sizes and crimp code to be mentioned on both part the die. 3) Tool should be compliant of testing according to IEC, UL and GS standards. Tool shall have features such as: • Auto retraction system • Manual retraction stop. • Feedback signals for improper pressure • Better battery capacity and with status display • Flexible and rotating head for easy crimping.			
3.08.00	Trefoil clamps			
3.08.01	Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc.			
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	Trefoil clamps shall have adequate mechanical strength, when installed at 1 mtr intervals, to withstand the forces generated by the peak value of maximum system short circuit current.			
3.09.00	Cable Clamps & Ties			
3.09.01	The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyster coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individua pieces of suitable length to meet the site requirements.			
3.10.00	Receptacles			
3.10.01	Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with RCCB/RCD of 30mA sensitivity having facility for manual testing/checking of operation of RCCB/RCD. Location and Minimum no of RC type receptacle TG and SG area shall be provided as per Annex-I attached.			
3.11.00	Cable Drum Lifting Jack			
	The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.			
3.12.00	Galvanising			
3.12.01	Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.			
3.12.02	The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified			
3.13.00	Welding			
3.13.01	The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595			
4.00.00	INSTALLATION			
4.01.00	Cable tray and Support System Installation			
4.01.01	Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.			
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4.01.02	Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.									
4.01.03	The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.									
4.01.04	The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.									
4.01.05	All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.									
4.01.06	In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.									
4.01.07	In fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc, fire retardant paint to be applied after installation cables.									
4.02.00	Conduits/Pipes/Ducts Installation									
4.02.01	The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.									
4.02.02	GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.									
4.02.03	Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. 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 with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material									
4.02.04	Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise									
	<table><tr><th>Conduit /pipe size (dia).</th><th>Spacing</th></tr><tr><td>Upto 40 mm</td><td>1 M</td></tr><tr><td>50 mm</td><td>2.0 M</td></tr><tr><td>65-85 mm</td><td>2.5 M</td></tr></table>	Conduit /pipe size (dia).	Spacing	Upto 40 mm	1 M	50 mm	2.0 M	65-85 mm	2.5 M	
Conduit /pipe size (dia).	Spacing									
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	100 mm and above	3.0 M		
4.02.05	For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.			
4.03.00	Junction Boxes Installation			
4.03.01	Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.			
4.04.00	Cable Installation			
4.04.01	Cable installation shall be carried out as per IS:1255 and other applicable standards.			
4.04.02	For Cable unloading, pulling etc following guidelines shall be followed in general:			
	a)	Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.		
	b)	While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.		
4.04.03	Cables shall be laid on cable trays strictly in line with cable schedule			
4.04.04	Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every one metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend. Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.			
4.04.05	Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.			
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4.04.06	Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.													
4.04.07	No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.													
4.04.08	In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.													
4.04.09	Wherever few cables are branching out from main trunk route troughs shall be used.													
4.04.10	Wind loading shall be considered for designing support as well Cable trays wherever required.													
4.04.11	Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.													
4.04.12	The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.													
4.04.13	Separation At least 300mm clearance shall be provided between: - HT power & LT power cables, - LT power & LT control/instrumentation cables,													
4.04.14	Segregation 1) Segregation means physical isolation to prevent fire jumping. 2) All cables associated with the unit shall be segregated from cables of other units. 3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set. 4) In switchyard, control cables of each bay shall be laid on separate racks/trays.													
4.04.15	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows: Minimum number of spare cores required to be left for interconnection in control cables shall be as follows: <table><tr><td>No. of cores in cable</td><td>No. of spare cores</td></tr><tr><td>2C,3C</td><td>1</td></tr><tr><td>5C</td><td>1</td></tr><tr><td>7C-10C</td><td>2</td></tr><tr><td>14C and above</td><td>3</td></tr></table>				No. of cores in cable	No. of spare cores	2C,3C	1	5C	1	7C-10C	2	14C and above	3
No. of cores in cable	No. of spare cores													
2C,3C	1													
5C	1													
7C-10C	2													
14C and above	3													
4.04.16	Directly Buried Cables a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint													
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	markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.			
	b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". 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 crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.			
4.04.17	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 every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.			
4.04.18	While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.			
4.05.00	Cable Terminations & Connections			
4.05.01	The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.			
4.05.02	Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.			
4.05.03	The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.			
4.05.04	Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.			
4.05.05	All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS																																	
4.05.06	All cable terminations shall be appropriately tightened to ensure secure and reliable connections.																																	
5.00.00	EARTHING SYSTEM																																	
5.01.00	Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts The earthing system shall be designed for a life expectancy of at least forty (40) years, for a system fault current of 50 kA for 1.0 sec. The minimum rate of corrosion of steel for selection of earthing conductor shall be 0.12mm per year. Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All areas under contractor scope of supply shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system. All the columns shall be earthed by nearby risers and earthmat grid spacing shall be maximum 15 mts. Minimum two nos of risers shall be provided for each equipment in SG area. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose. Sufficient nos of risers near the equipment shall be provided as per the system requirement. Ring type earthing around the offsite building shall be provided with interconnection of with main grid at minimum two points.																																	
5.02.00	The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects																																	
5.03.00	The material of the earthing conductors shall be as follows: <table><tr><td>1)</td><td>Conductors above ground level and in built up trenches.</td><td>-</td><td>Galvanized steel</td></tr><tr><td>2)</td><td>Conductors buried in earth</td><td>-</td><td>Mild steel</td></tr><tr><td>3)</td><td>Earth electrodes</td><td>-</td><td>Mild steel rod</td></tr></table>				1)	Conductors above ground level and in built up trenches.	-	Galvanized steel	2)	Conductors buried in earth	-	Mild steel	3)	Earth electrodes	-	Mild steel rod																		
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5.04.00	The sizes of earthing conductors for various electrical equipments shall be as below: <table><tr><th>Equipment</th><th>Earth conductor buried in earth</th><th>Earth conductor above ground level & in built-up trenches</th></tr><tr><td>a) Main earth grid</td><td>Min 40 mm dia. MS rod or as per actual calculation whichever is more</td><td>65 x 8mm GS flat</td></tr><tr><td>b) 33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear</td><td>---</td><td>65 x 8mm GS flat</td></tr><tr><td>c) 415 V MCC/ Distribution boards / Transformers</td><td>---</td><td>50 x 6mm GS flat</td></tr><tr><td>d) LT Motors above 125 KW</td><td>---</td><td>50 x 6mm GS flat</td></tr><tr><td>25 KW to 125 KW</td><td>---</td><td>25 x 6mm GS flat</td></tr><tr><td>1KW to 25 KW</td><td>---</td><td>25 x 3mm GS flat</td></tr><tr><td>Fractional House power motor</td><td>---</td><td>8 SWG GS wire</td></tr><tr><td>e) Control panel & control desk</td><td>---</td><td>25 x 3 mm GS flat</td></tr><tr><td>f) Push button station / Junction Box</td><td>---</td><td>8 SWG GI wire</td></tr></table>				Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches	a) Main earth grid	Min 40 mm dia. MS rod or as per actual calculation whichever is more	65 x 8mm GS flat	b) 33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	---	65 x 8mm GS flat	c) 415 V MCC/ Distribution boards / Transformers	---	50 x 6mm GS flat	d) LT Motors above 125 KW	---	50 x 6mm GS flat	25 KW to 125 KW	---	25 x 6mm GS flat	1KW to 25 KW	---	25 x 3mm GS flat	Fractional House power motor	---	8 SWG GS wire	e) Control panel & control desk	---	25 x 3 mm GS flat	f) Push button station / Junction Box	---	8 SWG GI wire
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	g)	Columns, structures, cable trays and bus ducts enclosures	---	50 x 6mm GS flat
	h)	Crane, rails, rail tracks & other non-current carrying metal parts		25 x 6mm GS flat
5.05.00	Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.			
5.06.00	Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground			
5.07.00	Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.			
5.08.00	Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.			
5.09.00	Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.			
5.10.00	Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.			
5.11.00	Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.			
5.12.00	Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.			
5.13.00	Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.			
5.14.00	Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.			
5.15.00	A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than			
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CLAUSE NO.	TECHNICAL REQUIREMENTS																																															
	300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.																																															
5.16.00	Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.																																															
5.17.00	Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be provided with bolted arrangement alongwith each earth pit, in order to facilitate measurement of earth resistance as & when required.																																															
5.18.00	On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.																																															
5.19.00	Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.																																															
5.20.00	Other Requirements of Earthing System: <table><tr><td>Standard/Code</td><td colspan="3">IEEE 80, IS 3043</td></tr><tr><td>Earthing System</td><td colspan="3"></td></tr><tr><td>Life expectancy</td><td colspan="3">40 Years</td></tr><tr><td>System Fault Level</td><td colspan="3">System Fault Level 50 KA for 1 sec</td></tr><tr><td>Soil resistivity</td><td colspan="3">Actual as per site conditions.</td></tr><tr><td>Min. Steel corrosion</td><td colspan="3">0.12mm/year</td></tr><tr><td>Depth of burial of main earth conductor</td><td colspan="3">600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.</td></tr><tr><td>Conductor joints</td><td colspan="3">By electric arc welding, with resistance of joint not more than that of the conductor.</td></tr><tr><td>Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.</td><td colspan="3"></td></tr><tr><td>Surface resistivity</td><td>- Gravel</td><td>3000 ohm-meter</td><td></td></tr><tr><td></td><td>- Concrete</td><td>500 ohm-meter</td><td></td></tr></table>				Standard/Code	IEEE 80, IS 3043			Earthing System				Life expectancy	40 Years			System Fault Level	System Fault Level 50 KA for 1 sec			Soil resistivity	Actual as per site conditions.			Min. Steel corrosion	0.12mm/year			Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.			Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.			Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.				Surface resistivity	- Gravel	3000 ohm-meter			- Concrete	500 ohm-meter	
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6.00.00	LIGHTNING PROTECTION SYSTEM																																															
6.01.01	Lightning protection system shall be in strict accordance with IEC : 62305 and latest IS standards.																																															
6.01.02	Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system																																															
6.01.03	Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.																																															
6.02.00	Down Conductors 1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode. 2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. 3. All joints in the down conductors shall be welded type. 4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval. 5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.																																															
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	6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system. 7. Lightning conductors shall not pass through or run inside GI Conduits. 8. Testing link shall be made of galvanized steel of size 25x 6mm. 9. Pulser system for lightning shall not be accepted. 10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.			
7.00.00	TESTS			
7.02.00	Type Test reports shall be furnished for the following			
7.02.01	Type tests on Cable Trays support system			
	a)Test 1A: On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals: i) Working load ii) Working load + point load iii) Off load iv) Proof load + point load v) Off load The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.			
	B)Test 1B: Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2			
	Test 2:On Main support channel type -C2 for cantilever arms fixed on both sides			
	a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals. i) Working load ii) Working load + Point load iii) Off load iv) Proof load + Point load v) Off load The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not			
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	exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied b) Test 2 B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side. Test 3 : Tests on Channel Fixed on Beam/Floor A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place. b) Test 3B: With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place. c) Test 3C: With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line. The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded. Test 4 : Channel Insert Test A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals. i) Working Load ii) Working Load + Point Load iii) Off Load iv) Proof Load + Point Load v) Off load The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied Test 5 : Channel nut slip characteristics (what ever applicable) Tests 5A1,5A2,5A3 : A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed.			
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	With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting. A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM. Tests 5B1,5B2,5B3: The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting. A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM. Test 6 Weld Integrity Test After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.			
7.02.02	Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.			
7.03.00	Routine/ Acceptance Tests			
7.03.01	Routine Tests			
	a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification. b) Physical & dimensional check on all equipments as per approved drawings/standards c) HV/IR as applicable. d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.			
7.03.02	Acceptance Test			
	a) Galvanising Tests as per applicable standards b) Welding checks c) Deflection tests on cable trays: One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm. d) Proof load tests on cable tray support system i) Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test. ii) Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done. iii) Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test. The procedure for carrying out tests at “d” above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity.			
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	e) The above acceptance tests shall be done only on one sample from each offered lot.												
8.00.00	COMMISSIONING												
8.01.01	The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance..												
8.01.02	Cables a) Check for physical damage b) Check for insulation resistance before and after termination/jointing. c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning. d) Check of continuity of all cores of the cables. e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor. f) Check for correct polarity and phasing of cable connections. g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc. h) Check for provision of correct cable tags, core ferrules, tightness of connections.												
8.02.00	Cable trays / supports and accessories 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories. 2) Check for continuity of cable trays over the entire route. 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports. 4) Check for earth continuity and earth connection of cable trays.												
8.03.00	Earthing and Lightning protection system 1) Earth continuity checks. 2) Earth resistance of the complete system as well as sub-system.												
9.00.00	ELECTRICAL LAYOUT PHILOSOPHY: While developing the layout the bidder must give due consideration to the following requirements: a) Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to: 1) Transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher. <table><tr><td>Oil capacity of individual transformer (in liters)</td><td>Clear separating distance (in meters)</td></tr><tr><td>5,000 to 10,000</td><td>8.0</td></tr><tr><td>10,001 to 20,000</td><td>10.0</td></tr><tr><td>20,001 to 30,000</td><td>12.5</td></tr><tr><td>Over 30,001</td><td>15.0</td></tr></table>			Oil capacity of individual transformer (in liters)	Clear separating distance (in meters)	5,000 to 10,000	8.0	10,001 to 20,000	10.0	20,001 to 30,000	12.5	Over 30,001	15.0
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CLAUSE NO.	TECHNICAL REQUIREMENTS	
	b.) Back Clearance - 1.5 M (Min.) c.) Side Clearance Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel (including spare panels/dummy panels etc.) 3. The following clearances shall be maintained for LT Switchboard. a.) Front Clearance i) For one Row of Swgr - 1.5M (Min) ii) For two Rows of Swgr - 1.5/1.75M depending upon the depth of panels etc b.) Back Clearance i) For single front - 1.0M (Min) ii) For double front - 1.5M (Min) c.) Side Clearance:Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800 mm + width of panel. For offsite areas, HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room. 4. Height of HT/LT Switchgear Room and Boiler MCC room i) With Bus Duct – 4.5 m (min) ii) Without Bus Duct – 4.0 m (min) Further no vertical bracings shall be envisaged in HT/LT switchgear room and associated cable vault area. 5. Cable trench/Cable vault For LT switchgear/MCC room at EL 0.0M, 1400 wide x 1400 deep cable trench shall be provided to route the cables. Horizontal cable trays shall be routed in cable trenches. c) Minimum clear working space around the equipment 1200mm d) In buildings having MCC, minimum 2 fire door along with one rolling shutter of adequate size/capacity shall be provided. e) The cable entry and exit from switchgear room shall be from 1.5 mtr (minimum) above FGL. f) Wash basin with mirror shall be provided in battery room.	
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Annexure-I

1.0 LOCATION OF LP3 :-

One number LP3 to be located in boiler MCC room at 28.0m in BC bay to supply RC receptacles in TG area.

Location of RC Receptacles in Turbine hall

Sl. No.	Name	Location of RC	No. of RC
1	Hot Well	0m (Near CEP)	2
2	Main Oil Tank	8.5m (AB Bay)	1
3	NGT Cubicle/ Gen Bushing	8.5m (AB Bay)	2
4	LAVT	7.5m (AB Bay)	2
5	HP-IP Turbine	17.0m (AB Bay)	2
6	LP Turbine	17.0m (AB Bay)	1
7	TD BFP	17.0m (AB Bay)	1
8	HP Heater - 5	17.0m (BC Bay)	2
9	Deaerator	38.0m (BC Bay)	2
10	LP Heater- 2	8.5m (BC Bay)	1
11	Valve Room	8.5m (AB Bay)	2

Total - 18 nos. RC Receptacles in Turbine Hall.

2.0 LOCATION OF RC RECEPTACLES

Location of Receptacles and Socket in Boiler area



FLOOR	63A WELDING RECEPTACLES		20A, 240V AC INDUSTRIAL SOCKET		20A, 24V AC INDUSTRIAL SOCKET	
			RA		RC	
	PROPOSED		PROPOSED		PROPOSED	
	QTY	LOCATION	QTY	LOCATION	QTY	LOCATION
GL-200	10	S7L,R MILL-B,E,G S17 ID-A,B P3L,R	7	S8L,R S21L, P3L,R ID-A,B	4	P2L,R ID-A,B
4710	3	MILL-A,D,J	3	MILL-A,D, MILL-J	8	MILL-A,B,C,D,F,G,H,J
8900	1	S18	1	S18, S14R	1	S12L
9700	2	S7L,R	2	S6L,R	2	S8L,R
11450	2	S8L,R	3	S6L,R S21	4	S10L,R S22L,R
17600					1	F1L
20500(APH BOTTOM), 21850	4	S18(2) S19L,R	7	S6L,R S17, S19L,R S6L,R	7	S9L,R S12L,R S18, S20L,R
21700(FEEDER FLOOR)	2	FEEDER A,J	4	FEEDER-A,C,F,J	4	FEEDER-A,C,F,J
23000	1	S17	2	S13L, S19		
25000(BURNNER BOTTOM, SPRAY STATION)	4	S8L,R S11L,R	5	S1L,R S11L,R S17	5	S1L,R S11L,R S17
28000(APH)	2	S19L,R	2	S19L,R	2	S19L,R
29200(APH, WIND BOX)	4	S20L,R S9L,R	4	S6L,R S20L,R	4	S8L,R S10L,R
32200	2	S9L,R	2	S6L,R		
33400	2	S12L,R	2	S6L,R S19L,R	2	S19L,R
38500	2	S3R, S10L				
42500	2	S10L,R	3	S6L,R S17	3	S9L,R S17
45300	2	S10L,R	4	S6L,R S11L,R	4	S8L,R S10L,R
48000	1	S1R	2	S14R S15L	2	S9L,R
48900	4	S18(2) S12L,R	4	S11L,R S12L,R	2	S11L,R
53600	2	S5L,R	3	S14R S10L,R	2	S5L,R
58000	4	S11L,R S14L S15R	4	S14R S15L S11L,R	2	S11L,R
59200(TRIPPER FLOOR)	2	LEFT, RIGHT	2	L,R		
61400	4	S11L,R S14L S15R	3	S14R S11L,R	2	S11L,R
68100	2	S11L,R	2	S6L,R		
77300	2	S10L,R	4	S6L,R S11L,R	2	S4L,R
83500	2	S10L,R	2	S12L,R		
86700	2	S3L,R	2	S11L,R	2	S11L,R
88600	1	S11L	2	S6L,R	2	S8L,R
95900	1	S1R	1	S1L		
ESP/FG I/L DUCT	4		2		4	
ESP/FG O/L DUCT	2		1		2	
ESP AT MANHOLE DOOR FLOOR	4	IN BETWEEN TWO PASS	4		4	
ESP AT TOP	2		1			
ESP AT -200	2	AT FRONT SIDE BOTH L&R	2			
TOTAL	86		92		77	



SUB-SECTION-B – 11

LIGHTING

CLAUSE NO.	TECHNICAL REQUIREMENTS 	
1.00.00	GENERAL	
1.01.00	This specification covers the general description of design, manufacture and construction features, testing, supply, installation and commissioning of the Station Lighting system equipment.	
2.00.00	CODES AND STANDARDS	
2.01.00	All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.	
2.02.00	Lighting Fixtures and Accessories IS:1913 General and safety requirements for luminaries. IS:2148 Flame proof enclosures of electrical apparatus. IS:1534 Ballast for fluorescent lamps. IS:1777 Industrial luminaire with metal reflectors. IS:2418 Tubular fluorescent lamps for general lighting services. IS:4013 Dust-tight electric lighting fittings. IS:8224 Electric Lighting fittings for Division 2 areas. IS:10276 Edison screw lamp holders. IS:10322 Luminaires. IS:13021 AC Supplied Electronic Ballasts for tubular fluorescent lamps. IS 16103 LED Luminaire Standards	
2.03.00	Lighting Panels, Switch-boxes, Receptacles and Junction Boxes IS:2147 Degree of protection provided by enclosures for low-voltage switchgear and control gear. IS:1293 Plugs & socket outlets of rated voltage upto and Including 250volts & rated current upto and including 16 Amps. IS:2551 Danger notice plates. IS:13947 Low voltage switchgear and control-gear IS:3854 Switches for domestic and similar purposes. IS:6875 Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V AC and 1200 V DC.	
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CLAUSE NO.	 TECHNICAL REQUIREMENTS		
2.04.00 2.05.00 2.06.00	IS:13703 Low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC. Conduits, Pipes and Accessories IS:2667 Fittings for rigid steel conduit for electrical wiring. IS:3837 Accessories for rigid steel conduits for electrical wiring. IS:9537 Conduits for electrical installations. Lighting Wires/Cables IS:694 PVC insulated cables for working voltages upto and including 1100 V IS:3961 Recommended current ratings for cables.(PVC Insulated and PVC sheathed heavy duty cables and light duty cables). IS:8130 Conductors for insulated electric cables and flexible cords. IS:10810 Methods of tests for cables. LED Luminaries 16101:2012 General Lighting. LEDs and LED modules Terms and definitions 16102(Part 1):2012 Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements. 16102(Part 2):2012 Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements. 16103(Part I):2012 LED modules for General lighting Safety Requirements. 15885(Part 2/Sec. 13) :2012 Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules 16104:2012 d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements. 16105:2012 Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources. 16106:2012 Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products 16107:2012 Luminaires Performance 16108:2012 Photo-biological safety of Lamps and Lamp Systems IS 513 Cold rolled low carbon steel sheets and strips		
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
2.07.00	IS 12063	Classification of degree of protection provided by enclosures.	
	IS 14700	Electro magnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.	
	IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.	
	IS 15885	Lamp control gear: particular requirements for (Part 2/Sec. 13) DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.	
	IS 4905	Method for random sampling	
	Electrical Installation Practices & Miscellaneous		
	IS:1944	Code of practice for lighting of public thorough fare	
	IS:3646	Code of practice for interior illumination.	
	IS:5572	Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation	
	S:6665	Code of practice for industrial lighting.	
	.	National Electrical Code	
	-	Indian Electricity Rules.	
	IS:5	Indian Electricity Act Colour for ready mixed paints & enamels.	
	IS:280	Mild steel wires for general engineering purposes.	
	IS:374	Electric ceiling type fans & regulators.	
	IS:732	Code of practice for electrical wiring installations.	
	IS:1255	Code of practice for installation and maintenance of power cables Upto and including 33KV rating.	
	IS:2062	Steel for general structural purposes	
	IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.	
	IS:2633	Methods for testing uniformity of coating of zinc coated articles.	
	IS:2713	Tubular steel poles for overhead power lines.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:3043	Code of practice for earthing		
	IS:5216	Guide for safety procedures and practices in electrical work.		
	IS:5571	Guide for selection of electrical equipments for hazardous areas.		
	BS:6121	Mechanical cable glands		
3.00.00	LIGHTING SYSTEM DESCRIPTION			
3.01.00	The illumination of various indoor and outdoor areas in the main plant & offsite area shall be provided as described here. The lighting system of various areas shall comprise of the following systems as identified in Annexure-B:			
	(a)	Normal AC Lighting System		
	(b)	Emergency AC Lighting System		
	(c)	DC Lighting System		
3.02.01	Normal AC Lighting System			
	Normal AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels (LPs) which in turn will be fed from the lighting distribution boards (LDBs)/Switch board MCC.			
3.02.02	Emergency AC Lighting System			
	This system shall be provided for certain important areas in the main plant. The lighting fixtures connected to this system shall be normally "ON" along with the normal AC system. These will be fed from emergency lighting panels (ELPs) which in turn will be fed 3-phase, 4-wire supply from the emergency lighting distribution boards (ELDB'S). These lights will go off for a few seconds in case of AC supply failure at Emergency Switchgear, but shall be automatically restored when Emergency Switchgear is energised by Diesel generator set.			
3.03.00	DC Lighting System			
3.03.01	At strategic locations in the main plant, a few lighting fixtures fed from 220V, DC supply, shall be provided to enable safe movement of operating personnel and access to important control points during an emergency, when both the normal AC and Emergency Lighting system fail. These lighting fixtures will be fed from 220V DC LDBs which in turn will be fed from DC lighting panels.			
3.03.02	The supply to the DC lighting panels shall be automatically switched ON in case of loss of AC supply at station service switchgear as well as Emergency switch-gear. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply to normal AC or emergency AC lighting system.			
3.03.03	Emergency DC lighting is to be provided, through self-contained DC emergency fixtures with four hours back-up duration, at strategic locations, in auxiliary/offsite buildings wherever DC supply system is not available. The fixtures shall be switched 'ON' automatically in case of failure of AC supply.			
3.03.04	For Coal Handling plant/FGD Plant Area 18W, 220V DC Lighting fixture shall be provided in underground portion of conveyor, each switchgear room, control room, office room, pump house, each drive floor of TPs,			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.00.00	staircases of various TPs and buildings and each local control area. DC lighting fixtures shall be fed from 220V DC LDB which in turn will be fed from CHP DC system. The supply to the DC lighting panels shall be automatically switched ON in case of loss of normal AC supply.			
	DESIGN PHILOSOPHY 1. A comprehensive illumination system shall be provided in the entire project areas under bidder's scope. 2. All outdoor lighting system shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel. 3. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting, including Transformer yard & Switch yard area, aviation obstruction lighting, Street lighting, security lighting, etc. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings. 4. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period. The Lux levels to be adopted for various area are indicated at Annexure - A. (placed at the end of this Chapter). 5. Different Lighting Systems envisaged for various plant areas are indicated in Annexure-B: While finalizing the detailed layout of lighting fixtures, the position/location and layout of equipments should be taken into account to have adequate illumination at desired locations. For CCR room Dimmable and Tunable downlighter fittings to be provided. 6. LED Luminaires: LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for DC lighting, hazardous areas & aviation lighting etc. conventional/LED type luminaires shall be used. However, aviation light in Lighting Mast shall be of LED type. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type. The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 100 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be "cool day light" (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. The LED luminaries shall have a minimum life of 25000 burning hours with 80% of lumen maintenance at the end of the life. LED shall conform to the LM 80 requirements.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS																							
	The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire. The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires. Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and water proof protection as per IS 12063. 7. Driver Circuit LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer. LED Drivers shall have following control &protections:- • Suitable precision current control of LED. • Open Circuit Protection • Short Circuit Protection • Over Temperature Protection • Surge Protection 8. Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for fixtures located in nonair conditioned area. <table><tr><td>(a.)</td><td>Office area (air conditioned)</td><td>:</td><td>0.8</td></tr><tr><td>(b.)</td><td>Office area (non airconditioned) and other indoor area</td><td>:</td><td>0.7</td></tr><tr><td>(c.)</td><td>Dust prone indoor and outdoor area</td><td>:</td><td>0.6</td></tr><tr><td>(d.)</td><td>Coal Handling area, Ash Handling Conveyor /Transfer Points etc.</td><td>:</td><td>0.5</td></tr><tr><td>e.)</td><td>Boiler Area</td><td>:</td><td>0.6</td></tr></table> Reflectance Factor:- Ceiling :0.8 Wall : 0.5 Floor : 0.2 Reflectance factor for CHP areas such as Bunker floor, TPs etc and AHP outdoor areas :- Ceiling :0.3 Wall :0.3 Floor :0.1 9. (i) All outdoor fixtures shall be weather proof and of min. IP65 degree of protection. (ii) For Indoor type of fixtures:-				(a.)	Office area (air conditioned)	:	0.8	(b.)	Office area (non airconditioned) and other indoor area	:	0.7	(c.)	Dust prone indoor and outdoor area	:	0.6	(d.)	Coal Handling area, Ash Handling Conveyor /Transfer Points etc.	:	0.5	e.)	Boiler Area	:	0.6
(a.)	Office area (air conditioned)	:	0.8																					
(b.)	Office area (non airconditioned) and other indoor area	:	0.7																					
(c.)	Dust prone indoor and outdoor area	:	0.6																					
(d.)	Coal Handling area, Ash Handling Conveyor /Transfer Points etc.	:	0.5																					
e.)	Boiler Area	:	0.6																					
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CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	(a) Surface/Pendent mounting: - IP 54 class of protection. (b) Recess Mounting (False ceiling):- IP 20 class of protection. 10. (a) Lighting panels shall be constructed out of 2 mm thick CRCA sheet steel. The door shall be hinged and the panel shall be gasketed to achieve specified degree of protection. Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have min. IP55 degree of protection. (B) All MCBs/Isolators/Switches/Contactors etc. shall be mounted inside the panel and a fibre glass sheet shall be provided inside the main door such that the operating knobs of MCBs etc., shall project out of it for safe operation against accidental contact. (c) Terminal blocks shall be 1100 V grade, clip-on stud type, made up of polyimide 6.6 or better suitable for terminating multicore 35 or 70 Sq. mm. stranded aluminium conductor incoming cable and 10 Sq. mm. stranded aluminium conductor for each outgoing circuits voltage. All terminals shall be shrouded, numbered and provided with identification strip for the feeders. (d) MCB's shall be current limiting type with magnetic and thermal release suitable for manual closing and automatic tripping under fault condition. MCB's shall have short circuit interrupting capacity of 9 KA rms. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping on fault even if the knob is held in ON position. MCB terminal shall be shrouded to avoid accidental contact. (e) Contactors of AC lighting panels shall be 3 no's, 63A, single pole continuous duty MCB, with neutral link, load make-break type suitable for 415 V, 3 phase 4 wire system. (f) DC switches shall be rotary type, 2 pole, continuous duty, load break type, quick make quick break, suitable for 220 V DC, 2 wire system. Switch knob shall be provided with ON/OFF indication. (g) Programmable Digital Timer shall be Electronic Astronomical Almanac Time switch with battery backup of min. TEN years, 4 Digit LED display, 24 hours range, manual override facility, 10 Amp 3 relay output, with NO/NC Contacts suitable for operation on 240V single phase AC supply. (h) Each lighting panel (LP-3) shall be fed from a 415V/42V, 3 phase-4 wire, 3 KVA transformer. The transformer shall be located inside the lighting panel itself. Transformers shall be dry type, natural air cooled with class F insulation or better. Impedance of transformer shall be 5%. Transformers shall be tested as per IS:11171. Off-circuit tap changer with +/- 5% in steps of +/- 1.25% tapping shall be provided. One minute power frequency withstands voltage for lighting transformer shall be 2.5 KV. (i) Lighting Panels shall have 20% spare outgoing feeders and shall be of following types:-		
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CLAUSE NO.	 TECHNICAL REQUIREMENTS			
	TYPE	INCOMER FEEDER	OUTGOING FEEDERS	DETAIL OF CONTENTS
	LP-1	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	18Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection
	LP-2	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	9 Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection
	LP-3	1 No., 4A fuse 3 KVA transformer,40A TPN MCB	24 Nos., 16A, 45V MCB	IP 55 degree of protection. Incomer shall be suitable for receiving 4Cx16 sq. mm cable and outgoing circuit shall be suitable for 2Cx16 sq. mm cable.
	LP-D1	1No. 220V,32 A, DP Isolator (2Cx35sq.mm cable)	6Nos.,16A, 220V DP Switch & Fuse	220V,32A DC Fuse, etc. outdoor type IP:55 degree of protection.
	11. Wires of different phase shall normally run in separate conduit. 12. Power supply shall be fed from 415 / 240 V normal AC supply, emergency AC supply and 220V DC supply through suitable number of conveniently located lighting distribution boards (LDB) and lighting panels (LP). AC lighting supply shall be isolated from main supply by 2x100% isolation transformers of max. rating of 50 KVA for 10/15 nos. outgoing feeder with changeover switch facility. The isolation transformer shall be fed from two different bus sections of MCC and fault level restricted to 3 KA at Lighting Panels.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
13.	Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. Further 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial areas. Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A,3ph,415V AC receptacle shall be provided in each floor of off-site buildings/ structures. Receptacles boxes shall be fabricated out of 2 mm thick MS steel hot dip galvanized or of not less than 2.5 mm thick die-cast aluminium alloy or fabricated out of 2 mm thick CRCA sheet with electro static powder coating. IP-degree of protection shall be applicable to receptacles Type 'RA &”RC’ only. Minimum no of receptacle in TG and SG area shall be provided as per Annex-I, of chapter B-10.				
	Receptacles shall be of following types:				
	Type	Switch rating	Socket & plug rating	Type & make of plug & Socket	Terminal Block size
	RA	20 A, SP240V AC(Industrial)	20A, 3 pin240 V AC	NTPC appd. make	1-4 way, suitable for loop-in loop- out of 10 sq.mm. Al. Conductor
	RB	16A, S.P240V AC	6A+16A6 Pin decorative Piano-key Type Switch	NTPC appd.make	1-4 way, suitable for loop-in loop- out of upto 10 sq.mm. Al. Conductor
	RC	20 A, SP24 V AC(Industrial)	20A, 3 pin24 V AC	NTPC appd. make	1-4 way, suitable for loop-in loop- out of 2 core -16 sq.mm. Al. Cable.
	14. In the hazardous areas like Hydrogen generation plant, fuel oil handling areas or anyother gas/ liquid fuel storage/ handling areas in bidder’s scope, lighting shall be flame proof.				
	15. The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group II C as per IS:2148 or class I, Division II as per NEC 70-428.				
	16. All fluorescent lamps shall be have "Cool day light" colour designation. The mirror optics type fluorescent fixtures shall have no iridescence effect. Fixtures with better efficiency and upgraded proven system may also be considered In candescent lamps may be used only with DC Lighting.				
	17. Aviation warning lights shall be provided as per the recommendations of ICAO and Director general of civil aviation, India. The arrangement of light should be marked such that the object is indicated from every angle in azimuth. The				
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.05.01	Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminium.			
4.06.00	Lighting Poles			
4.06.01	The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. The Poles shall be mounted above ground using base plate and minimum height of pole shall be 8 mtrsThe poles shall be hot-dip galvanized as per IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. TheSystem shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.			
4.07.00	Lighting Masts			
4.07.01	Suitable number of lighting masts shall be provided for entire plant..Lighting Mast shall be of continuously tapered polygonal cross section hot dip galvanised. The Mast shall be of 30M or suitable height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaires, suitable aviation warning light, lightning alongwith necessary power cables within the mast. The mast shall be delivered in not more than three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast The Mast together with the fixtures shall be capable of withstanding the appropriate wind loads as per IS: 875. The Mast shall be fabricated from special steel plates conforming to BS-EN10-025 and folded to form a polygonal section. Suitable feeder pillar with TPN MCB, contactors, timer, MCB and other necessary accessories for operation & protection of the mast and fixtures shall be provided.			
4.08.00	Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.			
4.09.00	A.C. normal, AC emergency and DC system wiring shall run throughout in separate conduits. Wires of different phase shall run in different conduits.			
4.10.00	Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run alongwith each conduit run. Cable armours shall be connected to earthing system at both the ends.			
4.11.00	Alternately Vendor may offer technically superior and proven product subject to approval of employer.			
4.12.00	Occupancy based Passive Infra-red sensors			
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CLAUSE NO.	TECHNICAL REQUIREMENTS													
5.00.00	Reliable occupancy based Passive Infra-red sensor shall be pro-vided in air conditioned office rooms suitable to cater the con-trolled lighting systems. The detection area shall be minimum 5 metres for standard room height of 3mt. All the calibrated set-tings shall be stored in non-volatile memory of PIR sensor which shall be unaffected by power supply fluctuations. If necessary, contactor shall be supplied along with sensor & may be located inside the switch box/Panel.													
5.01.00	TESTS For LED Fixture a) The contractor shall carry out the type tests as listed in this specification on the following types of LED fixtures to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of bid document and the same shall be considered for the evaluation of the bids. LED fixtures (Type test shall be conducted on one rating each of following type of LED fixtures. Rating for test conduction shall be decided by the employer during detailed engineering) a) High bay fixture. b) Well glass fixture. c) Street light fixture d) Surface mounted type fixture. e) Recessed mounted type fixture. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.													
5.02.00	For all other Station lighting equipment:													
5.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.													
5.04.00	Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S													
5.05.00	Type test reports of the following items as per technical specification requirements/ standards shall be submitted for approval. <table><tr><th>SL NO.</th><th>DESCRIPTION</th></tr><tr><td>i.</td><td>Lighting fixtures of each type</td></tr><tr><td>ii.</td><td>Lighting panel of each type (Degree of Protection)</td></tr><tr><td>iii.</td><td>Junction Box of each type.</td></tr></table> Type test reports for LED as per standards for following shall be submitted for approval. <table><tr><td>1. Visual and Dimension check</td></tr><tr><td>2. Proof of procurement of LEDs</td></tr><tr><td>3. Safety tests</td></tr></table>	SL NO.	DESCRIPTION	i.	Lighting fixtures of each type	ii.	Lighting panel of each type (Degree of Protection)	iii.	Junction Box of each type.	1. Visual and Dimension check	2. Proof of procurement of LEDs	3. Safety tests		
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
	a) Marking b) Construction c) Provision for Earthing d) External and Internal wiring e) Protection against electrical shock f) Endurance and Thermal g) Insulation resistance & electrical strength h) Resistance to heat fire & tracking i) Resistance to Humidity 4. Fire Retardant test 5. Performance tests (electrical, Photometric color and Life) 6. Burn-in Test 7. Power Cycling 8. Temperature rise test 9. Emission Tests a) Radiated & conducted emission b) Harmonics & flickers 10. Immunity tests				
	In addition, following test reports to be submitted for LED chip/LED luminaire: a) LED parameters like Lumen per watt, CRI, Beam angle from manufacturer. b) LM 80/IS: 16105 report. c) LM 79/IS: 16106 report.				
	5.06.00	Acceptance Test and Routine Test			
	5.06.01	All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.			
	5.06.02	Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks also. Switch boxes shall be made of 1.6 mm thick MS sheet with 3 mm thick decorative, Perspex cover. Switch box shall be hot dip galvanized. Switch boxes shall be of following types :			
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CLAUSE NO.	TECHNICAL REQUIREMENTS				
	TYPE No.	Switch	Fan Regulator*	Socket	
	SWB 1	5 A - 2 Nos.	-	-	
	SWB 2	5 A - 3 Nos.	-	5A - 1.No.	
	SWB 3*	5 A - 5 Nos.	1	5A - 1.No	
	SWB 4*	5 A - 7 Nos	3	5A - 1.No.	
	SWB 5**	5 A - 5 Nos	-	5A - 1.No.	
	* Space provision shall be kept for fan regulator in switch boxes.				
	** Shall have the provision for mounting the 16 A contactor.				
5.07.00	Galvanizing Tests				
5.07.01	The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.				
5.07.02	In addition following tests shall be conducted as acceptance tests.				
	(a)	Uniformity of coating - The coating of any article shall withstand for one (1) minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.			
	(b)	The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually.			
	(c)	In addition, the plating thickness shall be determined microscopically/ chemically or electronically.			
6.00.00	COMMISSIONING CHECKS				
	1.	On completion of installation work, the Contractor shall request the Project manager for inspection and test with minimum of fourteen (14) days advance notice.			
	2.	The Project manager shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.			
	3.	The installation shall be then tested and commissioned in presence of the Project manager.			
	4.	The contractor shall provide all, men material and equipment required to carry out the tests.			
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TECHNICAL REQUIREMENTS

5. All rectifications repair or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor without any extra cost. The handing over the lighting installation shall be effected only after the receipt of written instruction from the Employer/his authorized representative.
6. The testing shall be done in accordance with the applicable Indian Standards and codes of practices. The following tests shall be specifically carried out for all lighting installation.
 - (a) Insulation Resistance.
 - (b) Testing of earth continuity path.
 - (c) Polarity test of single phase switches.
 - (d) Functional checks.
7. The lighting circuits shall be tested in the following manner:
 - (a) All switches ON and consuming devices in circuit, both poles connected together to obtain resistance to earth.
 - (b) Insulation resistance between poles with lamps and other consuming devices removed and switches ON.

ANNEXURE-A

SI No.	Location**	Average Illumination Level(Lux)	Type of Fixture
(a)	Turbine Hall operating floor	200	High/medium bay LED luminaire
(b)	Turbine Hall Other Platforms	200	LED high/medium bay, LED well glass fixtures
(c)	Switchgear rooms, Charger, Rectifier room	200	Industrial type LED Luminaire
(d)	Control room, computer room, control equipment room	350	LED luminaire equivalent to Mirror optics with anti-glare features or down-lighter.
(e)	Offices, conference rooms, etc.	300	Decorative mirror optics TypeLED luminaire or LED down-lighter
(f)	Battery rooms	100	Totally enclosed corrosion Proof LED Luminaire
(g)	Transformer yard	20 (general) 50 (on equipment)	LEDLuminaire
(h)	Boiler platforms	100	LED well glass fixtures,

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(i)	Diesel generating room /enclosure, Compressor room, pump house etc.	150	LED medium bay/ Industrial type LED Luminaire
	(j)	Fuel oil pump house	150	Flame proof fluorescent fixtures suitable for division-2 hazardous area
	(k)	Cable galleries/vault	50	Industrial type LED Luminaire
	(l)	Street lighting- primary roads secondary roads	20 10	LED street lights
	(m)	Outdoor storage handling and unloading area	20	LED Luminaire
	(n)	Cement stores	150	Industrial dust proof type LED Luminaire
	(o)	Chemical stores/House	150	Corrosion proof LED Luminaire
	(p)	Permanent stores	150	LED high/medium bay / Industrial trough LED Luminaire
	(q)	Workshop. Building	150	LED high/medium bay / Industrial trough LED Luminaire
	(r)	Laboratory General Analysis area	150 300	Corrosion proof LED Luminaire
	(s)	Garage/Car Parking	50	Industrial type LED Luminaire
	(u)	AIS Switchyard and Substation	20(general 50(on strategic equipment)	LED Luminaire
	(v)	Transfer points, Sheds, tunnels,bunker house, Crusher house, Conveyor Gallery etc. in bidders scope	100	LED Dust tight/Well glass type Luminaire
	(w)	Facility building, canteen etc	150	Industrial type LED Luminaire
	(x)	Hydrogen Plant Building	150	Explosion proof HPMV/ Fluorescent fittings suitable for class-I and Division –IIC
	(y)	DC Lighting- Control room	-	LED down light fixtures, Decorative recessed
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CLAUSE NO.	TECHNICAL REQUIREMENTS 																																																																																		
	type with cylindrical reflector (z) DC Lighting- Other Area - LED Industrial Bulkhead (aa) Corridors, Walkways 50 LED Luminaire (ab) Building Periphery Lighting 10 LED Street Light fixture/ LED Luminaire (ac) Security Lighting along Boundary 10 LED Street Light fixture/ LED Luminaire (ad) ESP platform 150 LED well glass fixtures (ae) Gate complex/Time Office 150 LED Luminaire (af) GIS Hall – Not Applicable 150 LED medium bay/ Luminaire (ag) DM plant, water treatment plant CW Pump house, Raw water PH, Fire Water PH 150 LED high/medium bay / Industrial trough LED Luminaire ANNEXURE-B <table> <tr> <th>Sl.</th><th>Plant Areas</th><th>Normal AC Lighting System</th><th>Emergency AC Lighting System</th><th>220 V DC Lighting System</th><th>Portable DC Fixtures</th></tr> <tr> <td>1</td><td>TG Building(turbine hall, switchgear room etc)</td><td>80%</td><td>20%</td><td>√</td><td>—</td></tr> <tr> <td>2</td><td>Boiler Platform</td><td>80%</td><td>20%</td><td>√</td><td></td></tr> <tr> <td>3</td><td>DG Area/ Room</td><td>80%</td><td>20%</td><td></td><td></td></tr> <tr> <td>4</td><td>Compressor Room</td><td></td><td></td><td></td><td>√</td></tr> <tr> <td>5</td><td>ESP Control Room</td><td>80%</td><td>20%</td><td></td><td>√</td></tr> <tr> <td>6</td><td>Unit Control Room</td><td>70%</td><td>30%</td><td></td><td></td></tr> <tr> <td>7</td><td>Switchyard Control Room</td><td>80%</td><td>20%</td><td></td><td></td></tr> <tr> <td>8</td><td>Battery Room</td><td>80%</td><td>20%</td><td></td><td></td></tr> <tr> <td>9</td><td>Cable Spreader Room/ Vault</td><td>80%</td><td>20%</td><td>√</td><td></td></tr> <tr> <td>10</td><td>Hydrogen Plant</td><td>100%</td><td></td><td></td><td>√</td></tr> <tr> <td>11</td><td>Chemical House</td><td>100%</td><td></td><td></td><td>√</td></tr> <tr> <td>12</td><td>Fuel Oil Pump House</td><td>100%</td><td></td><td></td><td>√</td></tr> </table>					Sl.	Plant Areas	Normal AC Lighting System	Emergency AC Lighting System	220 V DC Lighting System	Portable DC Fixtures	1	TG Building(turbine hall, switchgear room etc)	80%	20%	√	—	2	Boiler Platform	80%	20%	√		3	DG Area/ Room	80%	20%			4	Compressor Room				√	5	ESP Control Room	80%	20%		√	6	Unit Control Room	70%	30%			7	Switchyard Control Room	80%	20%			8	Battery Room	80%	20%			9	Cable Spreader Room/ Vault	80%	20%	√		10	Hydrogen Plant	100%			√	11	Chemical House	100%			√	12	Fuel Oil Pump House	100%			√
Sl.	Plant Areas	Normal AC Lighting System	Emergency AC Lighting System	220 V DC Lighting System	Portable DC Fixtures																																																																														
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CLAUSE NO.	TECHNICAL REQUIREMENTS					
	13	Ash Handling Plant	100%		√	
	14	Water Treatment Plant	100%		√	
	15	CT Switchgear Room	100%		√	
	16	Cooling Towers	100%			
	17	Workshop	100%		√	
	18	Service Building	100%			
	19	Area Lighting	100%			
	20	Street Lighting	100%			
	21	Transformer Yard and Storage Yard	100%			
	22	Coal Handling Plant	100%		√	
	23	GIS Hall – Not Applicable	80%	20%		
	24	AIS Switchyard	80%	20%		
	DC Emergency Lighting:					
		Area			Average Lux Level	
	1	Unit Control Room			100	
	2	Control Equipment Room			100	
	3	Switchyard Control Room			20	
	4	Strategic Control Points (In TG Building & Boiler Area, Switchgear room, SWAS, Battery Room, UPS Area, TG Hall, Lube oil Room etc			20	
	5	Cable Vault & Galleries			1 fixture at every 20 metres spacing along walkways	
	6	Boiler Stair Case			1 fixture at every 20 metres spacing along walkways	
	7	Exit/ Entry of Main Plant Building			1 fixture	
	8	Fire Exit Sign			1 fixture	
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SUB-SECTION-B – 12

FIRE PROOF CABLE PENETRATION SEALING SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS	
1.00.00	CODES AND STANDARDS	
1.01.00	The fire proof cable penetration (FPCP) sealing system shall conform to the requirement of latest edition including amendments of BS:476 Part-20 Fire tests on Building materials and structures.	
1.02.00	Fire penetration seal complying with any other international standards will also be considered if it ensures performance equivalent or superior to standard listed above.	
1.03.00	The Bidder shall clearly indicate the standards adopted and furnish a copy of the English version of the latest editions of standards along with the bid, and shall clearly bring out the salient features for comparison.	
2.00.00	SYSTEM DESCRIPTION	
2.01.00	The fire proof cable penetration sealing system shall be of the following types; i) Type - A Type A fire sealing system is either Silicone foam or equivalent foam system or using individual blocks for each cable along with suitable frame work rated for one hour. Type A is to be implemented at floor openings below C&I panels, control panels/Boards etc. in CER & CCR/Control Room. ii) Type-B Type B fire sealing system is any proven fire sealing system rated for one hour. This will comprise of rest of wall and floor crossings of cables/cable trays, opening below HT/LT Switchgears/board other than those covered under Type A.	
2.02.00	The penetration system, shall be installed immediately after the completion of cable termination in a particular switchboard/control panel/area after clearance from the Project Manager.	
3.00.00	GENERAL INFORMATION	
3.01.00	The cables shall generally be laid in cable trays/racks, conduits, ducts. The fire proof cable penetration system shall be designed in such a way that the existing supporting structure/cable is not disturbed.	
3.02.00	The penetration system shall be suitable for site condition at 50 ⁰ C ambient temperature and relative humidity of 100%.	
3.03.00	The penetration system of each wall/floor crossing shall be adequately designed/sized such that 20% addition of cables is possible at any later date without disturbance/wastage of material in the penetration system.	
3.04.00	Contractor shall plan the schedule of supply of the materials in consultation with Project Manager and use the material within stipulated shelf life of material. After award of work, drawings for each penetration seal shall be prepared by the contractor after verifying the actual installation of cables at site and approval shall be taken from the Project Manager's	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	representative before proceeding with the actual work. The requirement of fire sealing material shall be quantified accordingly. Fire sealing material to be supplied shall be based on the net area to be sealed, wastage, thickness, density and other parameters as per the type test report approved under this contract. 4.00.00 TECHNICAL REQUIREMENTS 4.01.00 The fire proof cable penetration system shall fully comply with the requirements of BS:476 Part-20 and also to the requirements specified in this specification. 4.02.00 The penetration system shall prevent spreading of fire in cable beyond the seal system in case of fire and shall have minimum 1 hour fire resistance rating. 4.03.00 The penetration system shall be physically, chemically, thermally stable and shall be mechanically secure to the masonry/concrete/structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations. 4.04.00 The penetration system shall be capable of withstanding mechanical loads, foot traffic drop loads, vibrations, wind pressure, etc. 4.05.00 The penetration system shall be completely gas and smoke tight. 4.06.00 The penetration system shall retain integrity and perform satisfactorily even after remaining in water for long period. 4.07.00 The materials used in FPCP sealing system shall be non-toxic and harmless to the working personnel. 4.08.00 The penetration materials shall have no reaction with cable sheath/galvanising/painting of structural steel. 4.09.00 The penetration materials shall have anti-rodent and anti-termite properties. 4.10.00 The penetration materials shall have no shrinkage or cracking after the setting for the complete life of the power Plant. 4.11.00 Under normal load, short circuit and fire conditions, cables may be subjected to movement and vibration. The FPCP sealing system shall be designed to withstand and perform satisfactorily under these conditions. 4.12.00 The penetration system shall not affect the current carrying capacity of cables passing through it. 4.13.00 Asbestos shall not be used in the construction of fire penetration seal system. 4.14.00 The penetration system shall have life expectancy of 40 years. 4.15.00 The penetration system shall not emit any corrosive or toxic fumes or smoke on the unexposed face of the barrier.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS	
4.16.00	Any wastage of the compound during the process of mixing for preparing the FPCP sealing compound shall be to Contractor's account.	
4.17.00	For foam type of systems, only the foam shall form the penetration seal of specified rating, having the damming board removed after curing of the foam.	
5.00.00	PACKING AND STORAGE	
5.01.00	All materials and components of penetration system shall be supplied in packing to avoid contamination of materials due to dust/moisture and temperature during transit and storage. All packing shall be of durable quality and the date of expiry and the date of manufacture shall be printed on it.	
6.00.00	INSTALLATION	
6.01.00	The contractor shall take adequate care to ensure that cables are not damaged in any manner during penetration system installation.	
6.02.00	Wherever the floor/wall opening provided in the vicinity of penetration seals larger or smaller than that required for the cable fire penetration, these opening size can be reduced or increased in an approved manner by the contractor using the same materials as provided around the opening and of the same thickness. Generally the walls in the power station comprises of brickwork and the floors are made of RCC/steel work.	
6.03.00	The work to be carried out under this specification shall be done under the supervision of Project Manager's representative.	
6.04.00	All work shall be carried out in accordance with the agreed "field quality plan" and approved drawings. The "field quality plan" shall additionally specify the fire sealing material thickness, minimum cured density and other related parameters achieved in the approved type tests for the contract. The work shall be done to the satisfaction of the Project Manager and the same shall be subject to Project Manager's approval for acceptance.	
6.05.00	The installation shall be carried out in a neat workmen like manner by the skilled, experienced and competent workmen.	
6.06.00	Installation work at site shall be properly coordinated with other services.	
6.07.00	All materials being supplied or consumed during installation by the Contractor in the process of installation shall be of the best quality and according to standards. All materials shall be inspected and approved by the Project Manager before the same is used for installation work. Also regarding inspection of work, the engineer shall have the right to inspect at any stage during installation, testing and commissioning.	
6.08.00	The drilling and welding of building-steel or fixing supports etc. shall be carried out by contractor after taking prior approval of Project Manager.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS 	
7.00.00 7.01.00 7.02.00 7.03.00 7.04.00 7.05.00 7.05.01 7.05.02 7.05.03 7.05.04	TYPE TESTS, ROUTINE & ACCEPTANCE TESTS All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design change". Minor changes if any shall be highlighted on the endorsement sheet. Following Type test reports as per the setup and procedures given in subsequent clauses for the Fire proof cable penetration sealing system shall be submitted: a) The accelerated ageing test b) Water absorption test c) Fire rating test d) Hose stream test e) Vibration test followed by fire rating test Tests a, b, c and d should have been carried out on same test sample subsequently one after the other without any touching up/repair/modifications in the same sequence and in accordance with the clause 9.00.00. The test sample shall be assembled as per clause 8.00.00. Test indicated in clause 7.05.00 (e) above should have been carried out on a separate sample and as per the procedure indicated under clause 9.05.00. Physical, chemical and mechanical properties of various components/ingredients used should have been also be tested as a part of type tests. Test reports shall contain the following information: 1. Type of penetration material tested 2. Details of various components/ingredients used alongwith their catalogue.	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
7.06.00	3.	Physical, chemical and mechanical properties of various components/ ingredients used.		
	4.	Description of the various test assemblies tested.		
	5.	Details of method of conditioning.		
	6.	The observations as called for in BS:476 Part-20 and technical specification.		
	ROUTINE & ACCEPTANCE TESTS			
	Routine and acceptance tests to be carried out on Type-A and Type-B cable fire sealing system shall be mutually agreed based on the type of fire sealing material offered before placement of award.			
	8.00.00 TEST SPECIMEN ASSEMBLY			
	8.01.00	The test specimen shall be assembled as per enclosed drawing and shall resemble typical floor crossing cable penetration system.		
	8.02.00	The test specimen shall be designed to seal an opening of adequate size in a concrete slab of 200 mm thickness. Two lengths of 300/600 mm wide ladder type cable tray shall be assembled with required layer of XLPE/PVC insulated, PVC sheathed unarmoured cables in touching formation. Type and number of cables in the cable tray shall be as per enclosed drawing. Cables shall be adequately clamped with tray at both the sides of the penetration as shown in the drawings. However, for penetration system with blocks which require staggered arrangement, cables can be clamped at an adequate distance from the penetration and the tray need not pass through the penetration seal.		
	8.03.00	The opening in the test specimen then shall be sealed with fire proof cable penetration sealing materials.		
9.00.00 TEST PROCEDURES				
9.01.00	ACCELERATED AGEING TEST			
	The test specimen assembled as per clause 8.01.00 with damming board removed shall be subjected to accelerated ageing test by storing in air furnace where the temperature of the inside air shall be maintained at 85 degree centigrade for 168 hours. The temperature controlled furnace should have 7 air changes per hour approx.			
	9.02.00 WATER ABSORPTION TEST			
9.02.01	The test specimen shall be immersed in fresh clean water at a temperature of 20 deg. C ± 2 deg C. The test specimen must be separated from the bottom and sides of the soak tank by at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hour soak period the specimen shall be removed from water and mopped up with a damp cloth.			
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9.03.00	FIRE RATING TEST	
9.03.01	The test specimen after withstanding water absorption test shall be subjected to fire rating test as per BS: 476 part-20.	
9.03.02	Oil/Gas fired furnace shall be used for heating. The furnace shall have achieved standard time/temperature characteristics for fire tests as per BS:476 part-20.	
9.03.03	The pressure inside the furnace at the time of test shall be within 1.5 ± 0.5 mm water gauge.	
9.03.04	Cables in the test specimen shall be anchored on the hot side to a structure independent of the barrier and its penetrations. This is to ensure that any differential movement between the penetration and the cable that could occur during a fire, is produced in the type tests and the reliability of the integrity of the penetration is checked.	
9.03.05	Cables shall be protruding between 1 to 2 metre, from the penetration face on the unexposed side and protruding into the furnace as far as it is practicable with a minimum length 750 mm. The ends of the cables shall be capped on the unexposed face to prevent gases and fumes to escape from the furnace during the fire.	
9.03.06	The test specimen shall be subjected to fire test with surface exposed to controlled fire in the furnace confirming to time/temperature characteristics specified in BS:476(20).	
9.03.07	During the test the temperature of both the faces of the fire stop i.e. one which is exposed to fire and other unexposed shall be measured by calibrated thermo couples after regular interval of 5 minutes.	
9.03.08	Atleast 3 thermo couples shall be provided for temperature measurement of each face. The results at the end of the test shall be interpreted for failure criteria as under. 1. The system is deemed to have failed to maintain stability if there is a total collapse of the fire proof seal. 2. In case cracks are seen on the face of the fire stop or cracks through which the flame/ hot gas can pass the systems deemed to have failed to maintain integrity. The development of crack is characterised by appearance of black soot on cotton wool held near the penetration on the unexposed surface at a distance of about 100mm. 3. Failure shall be deemed to have occurred when the mean temperature of the unexposed surface of the specimen assembly increases by more than 140 ⁰ C above the initial temperature or if the temperature of the unexposed surface is increased at any point by more than 180 ⁰ C above the initial temperature. During the test the specimen shall meet all the three criteria simultaneously.	
9.03.09	Temperature measurement on the unexposed side of penetration seal shall be measured by thermocouples at a distance of 25 mm from unexposed side of fire stop.	
9.04.00	HOSE STREAM TEST	
9.04.01	A hose stream test shall be conducted on the test specimen immediately following a fire resistance test on that assembly. The specimen must first be removed from the furnace	
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9.04.02	since the hose stream is to be applied to the exposed face. This must be done quickly since it is the intention of the test that the stream be applied to the specimen whilst it is hot.			
9.04.03	The hose stream shall be long range narrow angle, (20 ⁰ - 90 ⁰ set at 30 ⁰ included angle). High velocity water spray provided from a 28 mm hose discharging through an appropriate nozzle. The water pressure shall be 5 bar calculated at the base of the nozzle and the minimum flow rate shall be 4.7 litres/second. The stream shall be supplied perpendicularly to the exposed face of the test specimen with nozzle 3 m away from the exposed face.			
9.05.00	Application shall be for minimum of two and a half minutes per 9 sq.m. of the test specimen including the barrier.			
9.05.01	VIBRATION TEST			
9.05.02	The test assembly is to comprise a single ladder rack penetration in 1 m x 1m high normal section of fire barrier which is securely supported. The penetration seal shall be formed in the middle of the barrier around 1 m length of 600 mm ladder rack. The tray shall be fully loaded with cables in touching formation. The penetration assembly shall be formed symmetrically through the fire barrier as in service. The penetration sealant material shall then be allowed to cure for atleast as long as the time required for conditioning to constant mass. A vibration test shall then be conducted on the sample as set out below.			
	The vibration shall be of 100 Hz frequency and of 0.5 mm amplitude (1.0 mm peak to peak) and this shall be applied to one rail of the ladder rack or the centre of a cross member secured to the two rails at 250 mm from the centre line of the penetration. This vibration shall be applied to the sample for the minimum period of 3 hrs. Immediately following this vibration test the barrier/ penetration assembly shall be successfully subjected to a fire test in accordance with clause no. 9.03.00.			
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SUB-SECTION-B – 13

SUBSTATION AUTOMATION SYSTEM

TECHNICAL REQUIREMENTS

CLAUSE NO.			
	SUBSTATION AUTOMATION SYSTEM (SAS) Preamble A complete integrated IEC 61850 compliant Substation Automation System (SAS) {M/s GE, formerly Alstom T&D} is available for SCCL 400kV switchyard. The control monitoring, and protection IEDs being provided for the 400kV Switchyard bays, under present scope, shall be integrated with the existing substation automation system.		
1.00.00	General Requirements		
1.00.01	The Substation Automation System (SAS) shall be based on the communication protocol IEC61850 and meet the requirements stipulated herein.		
1.00.01.1	The Bidder's scope of work shall include the supply, installation, testing and commissioning of the following: • Control and protection for the switchyard bays under present scope. • Integration of the IEDs for 400kV Switchyard Bays to the existing SAS by extending the switchyard LAN on 61850. All hardware including intelligent switches/LAN cable/OPGW etc. for the above shall be in scope of supply. Establishment of complete functionality of the total integrated system shall be in the scope of bidder. • Modification of the visual graphic displays and control/interlocking logics in the present system to accommodate the bays under present scope. • Reconfiguration of the gateways for third party interfaces (RLDC & OS Control room) to include the data pertaining to 400 kV switchyard bays under present scope. In case of any difficulty in re-configuring the existing Gateways, new gateways (in duplicate) need to be provided for this purpose and data is to be provided from these gateways to RLDC. • Switchyard service switchgear, cooling and tap changing system of EHV transformers (GT/UT/ST/ICT, as applicable) and reactors shall also be monitored and controlled from SAS (in consultation with OEM of transformer/reactor). BCUs, EFS, LAN Cables etc shall be provided for the control and monitoring (including monitoring of other auxiliary system like battery, battery chargers etc.) • GPS Time synchronisation of Switchgear Numerical relays shall also be in the scope of the bidder. • Testing of the final totally integrated system to ensure the interoperability and functionality and all the third-party interfacings as per specification. • Furniture required in the switchyard control room for housing computer /other devices shall be supplied. • Availability of the system supplied shall be 99.9%.		
1.01.0	The Bidder shall configure all the new data points for the bays under present scope for all the third-party interfaces (Load Despatch centres, Owner's DCS and Plant Information centre) and establish the availability of the signals. The bidder shall have to demonstrate the availability of all the desired information.		
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CLAUSE NO.	
1.02.00	The point-to-point testing of all signals for the EHV network at the plant end, protection equipment ends and the terminal end (Substation Controller and Operator Workstations) at the Substation shall be the responsibility of the contractor.
1.03.00	The point-to-point testing of all signals of the Main Plant DDC gateway shall also be the responsibility of the contractor. The contractor shall be responsible for all the works on switchyard SAS.
1.04.00	The architecture for the existing SAS is enclosed in the attached “ Substation Automation System Architecture ”. The Contractor shall provide full details of the offered system Architecture with the Bid. The architecture drawing for the existing SAS (M/s GE, formerly Alstom T&D) at SCCL is enclosed along with the tender drawing. All necessary data/configuration files and the detailed functional specification of the major components of the SAS will be made available to the successful bidder. Bidder shall ensure the seamless integration of the devices under present scope of supply to the existing SAS. present scope bays are to be implemented/ augmented in Existing SAS, However, any component/Hardware required for integration of proposed bays with existing SAS is under Bidder's scope. Augmentation of Existing bays is not in bidder's scope. Since no new line bays are envisaged in this contract, PLCC/FOTE are not envisaged.
1.05.00	The Bidder shall integrate independently operating subsystems such as Bay Control Units, Bay Protection units, and alarm annunciation into the existing SAS. The Bay Control Units, Bay Protection Units, Time Synchronizing Equipment, and relay test kit offered should meet the provenness criteria specified elsewhere. The contractor shall state any limitations in this regard during bidding and provide details of any similar systems supplied by the contractor that are in successful operation.
1.06.00	The SAS architecture shall be flexible to allow future extensions in switchyard. Only IEC 61850 protocols shall be used for inter-device communication.
1.07.00	The SAS at substation level and the communication network(s) shall be designed in a dual redundancy configuration. No single failure of any component/module of the SAS, including the communication links, shall cause loss of functionality of the SAS of more than a single bay.
1.08.00	Each component/module of the offered system, including all the communication links, shall be provided with built-in supervision and self-diagnostic features and any failures shall be alarmed to the operator.
1.09.00	The SAS shall be designed such that no periodic testing and maintenance is required for various subsystems comprising SAS. On-line testing routines for various subsystems of SAS shall be provided.
1.10.00	SAS shall be designed such that maintenance, modification or extension of its components / modules shall not cause shutdown of the complete SAS.
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1.11.00	The SAS and all its components shall be synchronized from a GPS time referenced clock receiver. The Time Synchronization equipment shall also be in contractor's scope of supply. A timing accuracy of better than 1 milli sec shall be achieved for all the devices within the SAS.
1.12.00	The Bidder shall provide all the documentation required during project implementation and during the life cycle of system for operation and maintenance. A list of such documentation shall be reviewed and approved by the Owner during detailed engineering.
1. 13.00	Owner intends to ensure interoperability of any third party IEC61850 compatible IEDs to be incorporated in future with the SAS. Bidder to provide all necessary data, configuration files, information etc. in this regard.
1.14.00	Contractor shall also provide adequate training for site personnel for operation, maintenance and troubleshooting of total system for 5 working days at SCCL site.
1.15.00	SF6 Gas densities shall be provided in SAS. Summarised MW and MVAR pertaining to lines, GTs, ST for stage-I and Stage-II shall be provided in SAS.
1.16.00	The General layout plan of the whole switchyard showing the geographical location of SWYD, SWYD CR, CCR, CERs is enclosed as tender drawing.
1.17.00	Bidder shall offer the Bay Level Units for the EHV system (each circuit breaker with associated dis-connector, Earth switches and instrument transformer shall comprise one bay) complete with Bay Control Units (BCUs) and Bay Protection Units (BPUs).
1.18.00	Switchyard service switchgear, cooling and tap changing system of EHV transformers (GT/UT/ST/ICT, as applicable) and reactors shall also be monitored and controlled from SAS (in consultation with OEM of transformer/reactor). BCUs shall be provided for the control and monitoring of breakers pertaining to 415V switchyard service switchgear and monitoring of other auxiliary system like battery, battery chargers etc. Additional LAN switches to be supplied loose by the bidder. Controls shall be provided as specified elsewhere in this specification.
1.19.00	The interface between BCU and Control Switching Devices (if applicable) shall be in Bidder's Scope. These Control Switching Devices (if applicable) shall be mounted in the respective bay control panel.
1.20.00	The Bidder shall furnish in the bid a composite list of bought out items (i.e., items not from his own manufacturing range) which the Contractor has included in his proposal along with the name of proposed sub-vendors, as a part of his proposal. However, the make and model of all bought out items supplied by the Contractor shall be as approved by the Owner during the detailed engineering stage.
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1.21.00	Dedicated Bay Control Units and Bay Protection Units shall be provided for each bay in the Contractor's scope of work as per offered bay configuration .		
1.22.00	One set of Relay test tool kit including Test Plugs shall also be supplied.		
2.00.00	SAS Reliability Requirements		
2.01.00	Each component and equipment offered by the Contractor shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, power supply, peripheral etc. shall be established considering its failure rates/meantime between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete system is assured. The guaranteed annual system availability shall not be less than 99.9% for the equipment under present scope of supply.		
2.02.00	The contractor shall submit reliability and maintainability values including detailed calculation for the projected overall system availability along with all assumptions supported by relevant standard for each device/equipment/system module which, with the help of a schematic of various systems connected in series or in parallel as the case may be , and Mean Time Between Failures (MTBF) and Mean Time to Repair (MTTR) values for the various equipment shall show that availability calculation is as specified in IEEE standard-P-1046 or equivalent.		
2.03.00	The contractor shall furnish in the bid a composite list of bought out items (i.e., items not from their own manufacturing range) which the contractor has included in their proposal along with the name of proposed sub-vendors, as a part of their proposal. However, the make and model of all bought out items supplied by the contractor shall be approved by the Owner during the detailed engineering stage.		
3.00.00	SAS Performance Requirements		
3.01.00	The existing SAS has duty cycle and other performance criterion as listed below. The bidder shall ensure that the same is maintained after integration of the bays under present scope. Any hardware/software augmentation required shall be in bidder's scope. It shall be the responsibility of the contractor to predict and indicate in the bid, the worst-case loading conditions and design the system accordingly to meet the same. The worst-case loading conditions shall include the following tasks as a minimum.		
3.01.01	All analog inputs scanning, and processing is in progress and all the data is being transmitted over the system bus every one second.		
3.01.02	Four operator comments for information from any Operator Workstation within a base period of one minute.		
3.01.03	A burst of 100 alarms is generated over a period of 10 s.		
3.01.04	One operator control is generated every 10 s.		
3.01.05	Data collection for logs/reports is in progress.		
3.01.06	Data collection for historical storage and trend function in progress.		
3.01.07	Data collection of fault records is in progress.		
3.01.08	All health monitoring functions/diagnostics in progress.		
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3.01.09	All output devices are in operation with rated performance/speed.			
3.01.10	All data are transferred to the Operator Workstations.			
3.02.00	Duty Cycle Time The Substation Controller processor spare duty cycle (free time): Under the worst case loading conditions, each processor shall have: i. 40% free time when measured over any two second period ii. 60% free time when measured over any one-minute period			
3.03.00	Inter Bay Bus and Substation Network Spare Duty (free time) The Inter Bay Bus and Substation Network shall have minimum 50% free time during the worst-case loading conditions measured over any two-second period. The Bidder shall furnish all necessary data to fully satisfy the Owner that the processor spare duty cycle figures quoted by the contractor are realistic and based on configuration and computational capability of the offered system and these shall be as per implemented system as commissioned at project site.			
3.04.00	Display Response Time The display response time under worst case conditions for all displays shall not be worse than 1.5secs for HMI displays. The display response time is defined as the time interval between the pressing of the last key demanding a display and completion of the requested display on CRT with full foreground and background information, and/or the updating of status indications according to plant changes, and/or the updating of event / alarm register according to alarm conditions-			
4.00.00	Software License and Upgrades			
4.01.00	The contractor shall provide all software licenses for all the software being used under the present scope. The license shall be provided on a site license basis and shall be valid for the plant / equipment life cycle. The license shall not be hardware / machine specific i.e., if any hardware / machine is changed / upgraded, the same software license shall be valid, and the Owner shall not have to seek fresh license or renewal of license. The contractor shall provide the license considering enough I/Os catering to the complete switchyard as shown in Tender SLD. In the case of anti-virus software, the license shall include regular updates until the end of warranty period. The Bidder shall guarantee that all software is defect free and meet the system specifications and undertake to fix any defects which may arise during the life of the system at no cost to the Owner.			
4.02.00	All software versions in components of the system shall be the latest official releases as on the date of shipment from works and shall include all software updates etc. released till that date. A certificate to this effect shall be furnished by the contractor at the time of pre-dispatch inspection for each software package. All new software revisions and/or patch updates that are released before the end of the warranty period which addresses system defects shall be implemented on site and the system re-tested to validate system integrity by the contractor at no cost to the Owner (This			
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5.00.00	excludes new revisions which provides additional functionality). The Bidder shall periodically inform the designated officer of the Owner about software updates / new releases that would be taking place after the system is commissioned. Design and Operating Requirement of SAS		
5.01.00	The control hierarchy and control levels of the SAS shall be based on the logical structure of the SAS which is as follows: Control Level 3 Remote Control Centre (OS Control Room) ↑ ↓ Control Level 2 Substation Level (HMI) ↑ ↓ Control Level 1 Bay Control Units ↑ ↓ Control Level 0 Switchyard Equipment		
5.02.00	The data exchange between Control level 3 and Control level 2 shall take place via the communication links provided by the owner for remote telemetry and control of the substation using IEC 60870-5-101/104/OPC protocol.		
5.03.00	The data exchange between Control Level 2 and Control Level 1 should take place via the inter-bay/ Station communication bus using the IEC61850 protocol. The inter-bay communication bus shall support peer-to-peer communications capability.		
5.04.00	The data exchange between Control Level 1 and Control Level 0 should be by means of hard-wired status / control signals between Switchgear Equipment and Bay Control /Protection Units and analog signals from CTs / CVTs.		
6.00.00	Substation Level Functionality		
6.01.00	Control Functions: - i. The SAS shall perform control functions on various switchyard equipment based on the status, analog and logical inputs acquired by SAS from various bay control units. ii. It shall be possible to monitor and control all the switchyard bays in the Bidder’s scope and the status of the Generator plant (status and analog signals such as MW, MVAR, Generation voltage, GRP Relay status, information etc.) from any of the existing and new Operator workstations at control level 2 i.e., either from switchyard control room or Main Plant control room. However, in case of maintenance, failure, or emergency, it shall be possible to control the individual bays from the Bay Control Units at Control Level 1.		
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6.02.00	iii. Clear control priorities shall ensure that operation of bay equipment (Circuit Breaker or Isolator) cannot be initiated simultaneously from more than one of the control levels. The priority shall always be on the lowest enabled control level. The selected control level shall be indicated at all the levels so that the operator is aware of his control capabilities. iv The SAS shall have provision of Device Tagging for all the substation devices. This function is to block the control of any substation device in such a manner that its command is prevented from Operator's Workstations. v Interlocking shall be implemented and shall ensure that no illegal switch operation can be performed by any control initiated from Control Level 3, Control Level 2 or Control Level 1. Interlocking shall be implemented on bay level as specified in relevant section of this specification. Sequence of Events and Alarm Management i. The SAS shall be capable of reporting on all Operator workstation and printers, the time sequenced record of events occurring in the substation. Separate logs shall be created for alarms and events and both the logs shall be time-tagged. Suitable filters, based on date and time, bay number, device number, function etc. shall be provided for both alarm as well as event logs for ease of viewing. Configuration of events pertaining to Stage-I/II bays shall be in the scope of Bidder. ii. All changes of alarms and statuses of switchyard equipment, including the alarms generated by Bay Control and Bay Protection units shall be recorded in non-volatile memory of SAS. It shall be possible to print historic events and real-time (unacknowledged and non-cleared) alarms after a system failure or reset with no loss of information. iii. All the alarms and events shall be time tagged at the Bay Controller or Bay Protection unit with a time resolution of 1 ms. iv The SAS shall include all the alarms and changes of plant statuses of the EHV networks. v The SAS shall acquire the alarm signals from Bay Control Units and Bay Protection Units with pre-set priorities and on receipt of an alarm shall generate an audible signal and report it either upon request or automatically to the respective printer. vi The Owner shall approve the list of alarms and plant statuses to be wired for Sequence of Events log and Alarm Management, during detailed engineering stage.
6.03.00	Historical Data Management and Trending i. The SAS shall maintain historical data in bulk non-volatile memory. The Historical Data shall be available for review and editing by authorized user. ii. The SAS shall monitor specified incoming information for historical data base, perform calculations on some of the incoming data and store incoming and calculated data in the non-volatile memory as historical data. iii. The historical data shall include Digital Fault Records and Sequence of Event logs received from bay protection units and bay control units.
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6.04.00	iv. It shall be possible to trend any measurement signal or summation of signals available in real time or data available in the historical database, in the shape of trend curves. Operations Log It shall be possible to create a daily operations log, in a user-defined format, about the substation operations as well as any failures / tripping therein. It shall also be possible to include on daily basis all the information required to keep a historical record of equipment behaviour.			
6.05.00	Reports The SAS should be capable of generating different types of reports, which can be presented in the operator interface screens upon request or programmed for automatic presentation in printers. It shall be possible to generate reports with information from both historical data base and real time information.			
6.06.00	Mass Storage Back up Either an industry standard DVD writer or tape streamer shall be provided to permit mass storage of all information existing in the computer hard disks such as application programs, database configuration, historical data, operations log etc.			
6.07.0	System Security and Interlocks i. Security features shall be provided at each level for safeguarding against unauthorized access. An alarm message will be displayed at the control centre and recorded in the logs for any unauthorised access attempts. The contractor shall provide software locks and passwords to the Owner’s engineers at site for all operating and application software at all levels. ii. The system shall maintain a SYSTEM CHANGE log, recording all system changes made along with the identification of the person making the change, date, time, and area of the system modified. The format and details of this log shall be finalised during detailed engineering. iii. No single failure either of equipment or power source shall result in rendering any part/subsystem of SAS inoperative, except that the information related to failed part/component is not available. iv. To ensure system security, the complete functionality of SAS shall be divided into various system security levels, to be decided by Owner during detailed engineering. Each security level shall offer certain functionality of the SAS to users’ e.g. Security level 0 – Display only Graphics, Real Time data and Historical Data Security level 1 – Normal Control Operations, Access to acknowledge alarm logs Security level 2 – Restricted Control Operations, access to edit/defeat bay interlocks Security level 3 – Complete access, engineering and maintenance of configurations and databases.			
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6.08.04	6.08.04.01	Provision for interfacing with owner’s PI (Plant Information) system on OPC: - OPC Server requirement: 1. The OPC server is envisaged for connectivity with owner’s PI server of OSI soft, USA. 2. OPC Data Access server with OPC Version 2.05a shall be supplied. Any other higher versions shall be backward compatible with version 2.05a. 3. Vendor shall ensure that data is accessible from the OPC server to a PI server of OSI Soft – version 3.4.375.38 and later (or any other 3rd party system) using PI-OPC client of OSISoft-version 2.3.7.0 and later (or any other 3rd party OPC client). 4. Timestamp when the measurement was made is to be used in the OPC Server. OPC server shall not use the time of the server as timestamp of the measured signal. 5. Vendor to indicate the latency between measurement and availability in OPC server. 6. All data like MW, MVAR, CB status, Metering Master Station data etc. shall be communicated through this OPC server. The number of tags to be licensed for the OPC Server as well as the maximum number of tags the OPC server can support shall be approved during detailed engineering. 7. Vendor shall inform method of testing the OPC compliance. Vendor shall demonstrate that data is accessible from the OPC Server using a standard 3rd party OPC client such as PI-OPC client of OSISoft, OPC client of Matricon. 8. Existing SCADA System has interface with Owners PI System on OPC. Additional interface shall be provided by the bidder as per the system requirement. Interfacing of SCCL Scope bays are not in the scope of the bidder.	
6.09.0		Main Plant DDC Interface	
	6.09.01	Suitable hardware and software, including adequate number of LAN switches/ redundant gateways, shall be provided to interface the switchyard SAS with each of the Main Plant DDC as shown in “Substation Automation System Architecture”.	
	6.09.02	Also, necessary data such as status of EHV circuit breakers, associated isolator and Earth switch, Bus Voltage/frequency etc. shall be provided to the main plant.	
	6.09.03	The exact signals shall be finalised during detailed engineering. (Note: The I/O list for above shall be made available to the bidder during detailed engineering).	
	6.09.04	It is the responsibility of the contractor to ensure proper information flow between the sub-systems of Main Plant DDC and SAS. The cable and associated hardware (Ethernet Fast switch etc.) required for connecting SAS network to the main plant DDC terminal shall also be provided by the contractor.	
	6.10.0	Interface with other Third-party Devices/Substation Automation System (SAS)	
	6.10.01	A fibre-optic extension of the substation Network LAN from switchyard to the Main Plant is to be provided by the contractor along with all associated hardware.	
	6.10.02	The HMI software at substation level shall also be so designed that it will require insignificant changes during interface with third party devices in the future. In any case, such an interface would not impair the working of existing SAS in anyway. Further, no shutdown of the SAS shall be required to achieve this integration.	
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6.11.0	Technical Requirements for Standalone Network Firewall																																
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7.00.0	NA																																
8.00.00	Communication Network Bus																																
8.01.00	General																																
	i. The Data communication network (substation/inter-bay bus) shall have bus configuration with either ring or star topology. The dual redundant buses, in case of star topology, shall be physically separate and shall be routed separately. Typical network architecture with ring topology is enclosed as “Substation Automation System Architecture”. ii. The contractor shall submit details regarding the communication system like communication protocol, bus utilization calculations etc. during detailed engineering. iii. Built-in diagnostics shall be provided for easy fault detection and to alarm any single bus failures. The design and installation of the main communication bus shall take																																
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8.02.00	care of the environmental conditions and hazardous area classification as applicable to similar services. iv. The system architecture shall allow several application protocols to co-exist on the application layer of the LAN stack. Substation Network Bus i. The substation network LAN configuration/protocol shall be as per the Tender drawing. The substation network LAN shall be an Ethernet LAN based on IEEE802.3 Ethernet standard using the IP protocol. It shall allow inter-operability with LANs from other vendors or with IEDs (Intelligent Electronic Devices) from other vendors in future, supporting IEC 61850. ii. CAT5e or better UTP cables or fibre optic cables shall be employed for all Ethernet data communication bus. 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. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure. The communication shall be made in 1+1 mode, excluding the links between individual bay IEDs to switch, such that failure of one set of fibre shall not affect the normal operation of the SAS. Each fibre optic cable shall have four (4) spare fibres. Fibre optic cables shall be used wherever the Ethernet connection is more than 50m, or where the connection extends between rooms or buildings. The Contractor shall ensure that structured cabling philosophy and good engineering practices as per internationally accepted standards are followed, for ease of maintenance and traceability, and that fibre-optic cables are adequately protected. Armored Fibre Optic cables shall be used in all cable routes containing other armored electrical cables. The armoured fibre optic cables shall be run in G.I. conduit wherever laid underground or without trays. iii. The LAN shall have a data communication speed of minimum 1 GBps. It shall be sufficient to meet the responses of the system in terms of displays, monitoring, and control commands according to the design. iv. Suitable hardware and software interface shall be provided to link Employer's OPC Compliant main plant DDC station bus.		
8.03.00	EHV Inter Bay Network Bus i. An Inter Bay Communication bus shall be provided for the EHV network, which shall support peer-to-peer communication, and communication to the Substation Controller.		
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	ii. The communication protocol used for all devices including Bay Control Units and Bay Protection Units shall be the IEC61850 protocol. No hardwiring of alarms shall be permitted between Bay Protection Units and Bay Control Units. As a minimum, all Bay Controller Units and primary relays/ protection relays, Bus-Bar protection and multi-functional Over current and Earth fault protection relays offered shall support the IEC61850 protocol. iii. Fibre optic cables shall be used for Inter Bay/Station Level Communication Bus. Contractor shall ensure that structured cabling philosophy and good engineering practices as per internationally accepted standards are followed, for ease of maintenance and traceability. Electrical data connections may only be used within a cubicle of the same bay.
8.04.00	NIL
09.00.00	Bay Level Functionality i. The Bay Level Functionality shall be built in Bay Control Units (BCUs) and Bay Protection Units (BPUs). ii. Dedicated Bay Control units and bay Protection units shall be provided for each bay in the contractor's scope of work. Also, one number BCU shall be provided for the control of SWYD service LT Switchgear. Controls shall be provided as specified elsewhere in this specification. For Transformers and Reactors, at least two (redundant) BCUs shall be provided in the Transformer/Reactor MB (or in a separate panel near the Transformer/Reactor MB as per the site-specific conditions) for monitoring and control of Transformers (GT/UT/ST/ICT, as applicable) /Reactors. iii. BCUs and Bay Protection Units shall be provided at Control Level 1 i.e., Bay Level of Logical Architecture, to facilitate control, monitoring, and protection of switchyard equipment. One Bay Control Unit shall provide complete functionality for one EHV bay. Each set of BCUs shall have sufficient analog and digital inputs to acquire the status of each circuit breaker, isolator, earth switch, Transformer parameters / tap position etc. of present scope of bays in Bidder's scope. A minimum of 64 Digital Inputs and 24 Digital Outputs per bay shall be provided in associated_Bay Control Units. A minimum number of 16 Analogue input channels per bay shall also be provided in the associated BCU. Rating of the various analogue input channels (110 V /1 A /4-20 mA) shall be decided during detail engineering. iv. BCU & BPU shall be mounted in different panels. All BCUs and Bay Protection Units shall be provided with self-diagnosis and supervision functions to ensure maximum availability. BCUs shall require no periodic routine maintenance and testing. An alarm contact shall be provided for hardware failures, failures of internal and external auxiliary supplies etc. Special algorithms shall be provided
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	to check the microprocessor's memories. A watchdog function shall supervise the execution of program by the microprocessor. v. Distribution of BPU/BCU panels of 400 kV bays shall be finalised during detailed engineering. vi. Space for mounting Controlled Switching Device of circuit breaker shall be provided in respective BCU Panel. vii. The layout of equipment/panels shall be subject to Owner's approval.			
09.01.00	Bay Control Units (BCU)			
09.01.01	Control and Protection Features of BCUs			
	The Bay Control Units shall have following built-in functions: i. Mimic control panel to display graphically the bay configuration, status of the plant, analogue measurands, alarms, and offer bay level control. iii. Switching of Switchyard Bay Equipment depending on conditions such as interlocking, synch-check, control mode, or external status condition. Adequate safety features like prevention of double operation, command supervision, block/de-block, over-riding the interlocking etc. shall be provided. All such security features shall be finalized and approved by Owner during detailed engineering. iv. Status Supervision of switchyard equipment Status supervision/control of transformers/reactors as decided during detailed engineering and for Generator Transformer (GT) as per IO signal list mentioned in drawing no: 0000501-POE-A-004(Rev-01). v. Interlocking Function to prevent unsafe operation of switchyard equipment such as circuit breakers, isolators, earth switches etc. Interlocking shall be implemented on bay level, by user-friendly, menu-driven configuration software within the BCU, Interlocking shall operate independent from the Substation Controller. Signalling of statuses between bays shall be performed by inter-bay communication (peer-to-peer) i.e., Goose messaging. The auxiliary contacts of each of the equipment shall be wired to the BCU for this purpose. However, for that equipment, which are required for interlock of other bay equipment, two sets of their contacts shall be wired to BCUs of two different bays. Such interlocks involving more than one bay equipment shall be realized through goose messaging. An over-riding / bypass function for bay-level interlocking shall be provided at appropriate security level for maintenance or during emergency conditions. Failure of any one BCU shall not affect the interlocking at any other bay, only the bay with failed BCU shall not be able to operate. This shall be achieved by providing a backup mechanism in case of failure of one BCU which affects the interlocking in another BCU (e.g., a backup mechanism for monitoring the status of the bus bar earths), to allow the remainder BCUs to function with full interlocking. The interlocking logic shall be defined during the details engineering phase to prevent illegal operation. vi. Analog Measurements for bay voltage (per phase), current (per phase), frequency, MW and MVAR, tap position / gas parameters / winding temperature			
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		of Transformers. These measurements shall not require the use of any intermediate transducers. The accuracy of measurement shall be 0.5% for voltage, current and frequency, and 1.0% for MW and MVAR. The measured and computed values shall be displayed locally on BCU and on operator’s workstation located in central control room. vii. Event and Alarm Handling: BCUs shall acquire all the bay level alarms and events from field inputs with a resolution and time tagging of 1 milli sec and shall transfer these to operator’s workstation over substation LAN. viii. Synchronization Check Feature: Synchronization Check feature shall determine the difference between the amplitudes, phase angles and frequencies of two voltage vectors. Checks shall be provided to detect a dead line or bus bar. The voltage difference and phase angle difference settings shall be adjustable.	
09.02.00		Bay Protection Units	
09.02.01		General	
		i. Trip commands from Bay Protection Units shall be hard-wired directly to appropriate switchyard equipment. Also, critical interlocking data between Bay Protection Units and Bay Control Units, including the substation level interlocks such as bus bar protection trip etc. shall also be hard-wired to ensure complete bay level functionality even in case of failure of substation LAN. The interlocking information to be hard-wired between Bay Protection Units and Bay Control Units shall be decided by Owner during detailed engineering stage. ii. NIL iii. NIL. iv. Relay parameterization for SWYD/GRP relays shall be possible from the EWS.	
09.02.02		General Requirements of Numerical Relays and Auxiliary Relays	
		i. All numerical relays, auxiliary relays and devices comprising the Bay Protection Units shall be of types, proven for the application, satisfying the requirements specified elsewhere and shall be subject to the Owner’s approval. ii. The necessary auxiliary relays, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when the relay is de-energized, shall be employed in the circuits. iii. Relays shall be provided with self-reset contacts except for the trip lockout, which shall have contacts with a manual reset feature. Manual resetting shall be possible from Control Level 2 as well as Control Level 1 with suitable authorization.	
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09.02.03	protection and control schemes over and above its inbuilt protection functions algorithm. xiii. All numerical relays shall be supplied with all the protection function/features in disabled condition. Relevant features/protection function shall be enabled at the time of commissioning at site as per approved logic and relay settings. xiv. BPU offered shall have adequate I/Os for function realization. Use of auxiliary relays (contact multiplication) shall be permitted only when the entire product range does not support any further hardware augmentation for additional I/Os. xv. Configuration/ scheme logics /relay settings shall be submitted by the Contractor for approval during detailed engineering. Protection for Main Generator Circuit i. For protection purpose, each Main Generator Circuit comprises the Generator, associated Generator Transformer, Excitation transformer and the Unit Transformer. Dedicated Bay Protection Units (BPUs), comprising numerical relays for various protection functions listed in following clauses, shall be provided for each Main Generator Circuit to achieve comprehensive protection for all types of faults and abnormal operating conditions. Numerical relays constituting the BPUs shall meet the requirements of Clause 9.02.02 above. ii. The BPU for each Generator Circuit shall be mounted in Generator Relay Panels to be located in the Control Equipment Room (CER) for respective Generator Unit. The Engineering and Fault Recording Stations shall be connected to the Substation Level LAN operating on IEC 61850. iii. The Engineering Stations shall allow following functionality related to Numerical Relays for all the Generator Circuits: - Extract all the alarms, events and fault data captured by numerical relays. - Change / upload Relay Settings for various numerical relays. - Share the data as above with switchyard SAS through Substation Level LAN. iv. The numerical relays constituting the BPU for each Main Generator Circuit, shall be configured into two independent Numerical Protection Systems, each fed from a separate DC supply, such that one numerical protection system shall be always available to detect and operate for any type of fault in the Generator Circuit, under condition of failure of the other numerical protection system AND/OR on failure of the associated DC supply systems of other numerical protection system. Group II of Generator protection shall be on a different hardware platform than Group I protection. Individual group of protection systems shall be connected to independent set of hand reset trip relays. Further the system shall have facilities to accept binary signals of various alarms and trip conditions of the Generator transformer, Excitation Transformer, and unit transformer with complete galvanic separation. All interface and coordination requirements with the control, interlock and protection schemes provided for the switchyard shall be achieved. v. The alarm/status of each individual protection function and trip operation shall be communicated to Main Plant DDC. Adequate IOs shall be considered for interfacing with
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	other systems like Turbine, excitation, DCS, Switchgear, Transformers, and switchyard. The numerical system shall have built-in features/ hardware interface to provide such inputs to DDC for analogue/digital values. vi. Protection function of two different equipment shall not be clubbed. The Numerical Generator Protection System shall comprise the protections indicated in the following table, which also contains the preferred grouping of various protections: <table><tr><th>S. No.</th><th>Protection Function</th><th>Preferred Grouping of Protection Functions</th></tr><tr><td>1</td><td>Duplicated Generator Protection (87G)</td><td rowspan="2"></td></tr><tr><td>2</td><td>Overall Differential Protection (87GT)</td></tr><tr><td>3</td><td>Generator Transformer Differential Protection (87T)</td><td>87T & 87GT shall be realized in different relays.</td></tr><tr><td>4</td><td>Stator Earth Fault Protection covering 100% of winding (64G1) based on injection principle</td><td rowspan="2"></td></tr><tr><td>5</td><td>Duplicated Stator Standby Earth Fault Protection covering 95% of winding (trip) (64G2)</td></tr><tr><td>6</td><td>Inter-turn Fault Protection (95G)</td><td></td></tr><tr><td>7</td><td>Duplicated Loss of field protection (40G1/2)</td><td>40G1 and 40G2 shall be on two different channels of protection.</td></tr><tr><td>8</td><td>Duplicated Back up Impedance Protection, three pole (21G)</td><td></td></tr><tr><td>9</td><td>Backup Earth Fault Protection on Generator Transformer HV neutral (51NGT)</td><td></td></tr><tr><td>10</td><td>Duplicated Negative Sequence Current Protection, alarm and I₂²t element for trip (46G) matching with the machine characteristics</td><td></td></tr><tr><td>11</td><td>Duplicated Low-Forward Power / Reverse power Interlock for steam turbine generator (37/32G1 & 37/32 G2), (with a minimum setting range of 0-1%) each with following two stages a) Short time delayed interlocked with turbine trip (0-10 sec) b) long time delayed independent of turbine trip (0-60 sec)</td><td>37/32 G1 and 37/32 G2 shall be in two different channels of protection.</td></tr><tr><td>12</td><td>Two Stage Rotor Earth Fault Protection (64F) based on injection principle. The relay shall be capable of monitoring the healthiness of injection circuit and raising an alarm in case of open discontinuity in injection circuit.</td><td>Setting Range for Rotor E/F Protection (Alarm/Trip) – 1KΩ to 20KΩ</td></tr></table>			S. No.	Protection Function	Preferred Grouping of Protection Functions	1	Duplicated Generator Protection (87G)		2	Overall Differential Protection (87GT)	3	Generator Transformer Differential Protection (87T)	87T & 87GT shall be realized in different relays.	4	Stator Earth Fault Protection covering 100% of winding (64G1) based on injection principle		5	Duplicated Stator Standby Earth Fault Protection covering 95% of winding (trip) (64G2)	6	Inter-turn Fault Protection (95G)		7	Duplicated Loss of field protection (40G1/2)	40G1 and 40G2 shall be on two different channels of protection.	8	Duplicated Back up Impedance Protection, three pole (21G)		9	Backup Earth Fault Protection on Generator Transformer HV neutral (51NGT)		10	Duplicated Negative Sequence Current Protection, alarm and I ₂ ² t element for trip (46G) matching with the machine characteristics		11	Duplicated Low-Forward Power / Reverse power Interlock for steam turbine generator (37/32G1 & 37/32 G2), (with a minimum setting range of 0-1%) each with following two stages a) Short time delayed interlocked with turbine trip (0-10 sec) b) long time delayed independent of turbine trip (0-60 sec)	37/32 G1 and 37/32 G2 shall be in two different channels of protection.	12	Two Stage Rotor Earth Fault Protection (64F) based on injection principle. The relay shall be capable of monitoring the healthiness of injection circuit and raising an alarm in case of open discontinuity in injection circuit.	Setting Range for Rotor E/F Protection (Alarm/Trip) – 1KΩ to 20KΩ
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	13	Duplicated Definite Time Delayed Over-Voltage Protection (59G)		
	14	Duplicated Generator Under Frequency Protection (81G) with df/dt elements		
	15	Over Fluxing Protection for Generator (99G) * & Generator Transformer (99 GT)		
	16	Duplicated Accidental Back Energization (Dead Machine) protection (50GDM) on two principles based on U/V and O/C b) based on CB status and O/C	50 GDM based on two principles shall be on two different channels.	
	17	Duplicated Generator Pole slipping protection(98G)		
	18	Unit Transformer Differential Protection, 3 pole (87UT)	87UT & 51UT shall be in different channels.	
	19	Unit Transformer back-up over current protection (51UT)		
	20	Unit Transformer LV REF (64UT LV)	64UT LV & 51NUT shall be in different channels.	
	21	Unit Transformer LV back-up earth fault protection (51NUT)		
	22	Gen Transformer OTI / WTI trip	OTI & WTI trip shall be on different channels	
	23	Gen Transformer Buchholz / PRV / other mechanical Protections		
	24	Unit Transformer OTI / WTI trip	OTI & WTI trip shall be on different channels	
	25	Unit Transformer Buchholz, PRV / other mechanical Protections		
	26	Alarm for all cooler / OLTC trouble for GT/UT as applicable.		
	27	Excitation Transformer Differential Protection, (87ET) ##	87ET & 51ET shall be in different channels.	
	28	Excitation Transformer back-up over current protection (51ET) ##		
	29	GT LV Earth Fault*		
	30	GCB LBB*		
	31	Following general functions shall also be provided a) VT fuse failure relay (based on voltage balance principle) b) Trip Relays as required c) Trip circuit / Trip relay / DC supervision		
	*Applicable for GCB scheme only ## Applicable for Static excitation only			
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09.02.03.01	Generator Disturbance Recorder i. One Disturbance / Fault Recorder (DFR) shall be provided for each generator. ii. Offered DFR shall be Microprocessor based used to record the graphic form of instantaneous values of voltage and current in all three phases and neutral, open and closed positions of relay contacts and breaker during disturbances. iii. It shall have the facility of fast scan as well as slow scan to record transient as well as dynamic performance of the system. iv. The DFR for each generator circuit shall have 8 analog/16 digital inputs in both slow scan and fast scan. v. Slow Scan Feature a) The input for slow scan rate shall at least be MW, MVAR, field voltage, frequency and generator terminal voltage. Any transducers, if required, shall be supplied. b) Shall be suitable to record the frequency excursions and response of generator field and governor control on system fluctuations. c) Shall have scan rate in the range of 2.0 to 50.0 Hz d) The Non-volatile memory in the DR shall be suitable for recording for a minimum of 15 minute at scan rate corresponding to the offered lowest scan rate with possibility to dedicate 10% of the memory space in pre-fault zone of recording. e) The frequency response of analogue signals shall be 25 Hz or better. vi. Fast Scan Feature The fast scan feature of generator DFR shall meet the requirements specified elsewhere for the Digital Fault Recording for EHV Lines. vii. The DFR provided for each generator circuits shall be wired to an Engineering and Fault Recording Station to be located in the respective CER as shown in the relevant SCCL drawing. It shall be possible to extract the DFR records from this Engineering and Fault Recording Station for review and analysis. In addition, a laptop shall also be supplied to facilitate downloading of DFR records locally. Suitable communication port shall be provided for this in each of the DFRs. The minimum configuration of the laptop shall be i5, 8GB RAM, 500GB SSD. Same shall be finalized during detailed engineering.		
09.02.03.02	Relays / transducers for Main Plant DDC interface (if applicable) i. Four (04) interposing relays and one as mandatory spare shall be provided for each generator circuit breaker in respective Generator relay panels for (closing and tripping of the generator bay breakers from Unit Control Room). These relays shall be energized from 24V DC supply, and the auxiliary contacts shall be suitable for energising close and trip coil of EHV circuit breaker. ii. Following transducers shall be provided in each of the generator relay panel for: a) EHV Bus Voltage and frequency b) Generator phase Currents and Phase Voltages c) Generator Frequency d) Generator power factor e) Generator Active and reactive power Multifunction transducer with independent output for each parameter can also be provided. However, in this case two sets of multifunctional transducers shall be provided.		
09.02.03.03	METERING for Generator circuit The following integrating meters shall be provided in the generator circuit:		
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	a) ABT meter for generator circuit and each LV incomer of Unit Transformer b) Meter shall be as per the requirements outlined in <u>clause 10.00.00</u>. These meters will be located in Generator Relay Panel		
9.2.4	Protection for EHV System (EHV) a) The general protection requirements for the EHV systems are indicated in the tender drawing for switchyard protection SLD. Existing bus bar protection details of SLD are as follows: CU- ALSTOM (P741) and PU-ALSTOM (P743). b) The Total critical fault clearing time, including the circuit breaker operating time, from fault initiation in any part of the system under all conditions shall not be more than 80 ms for faults within zone-I reach (i.e., up to 80% of line length) and 100 ms for end zone faults including carrier transmission time of 20 ms. c) The SIR values for the operating time of Relays for the SWYD feeders shall be between 4 and 15. The Rated break time for the EHV circuit breaker, as offered, shall be considered for the purpose of circuit breaker operating time. The contractor shall furnish the operating time curves at various SIR values for all types of faults.		
9.2.5	Nil		
9.2.5.1A)	Sequence-of-Event Recording Sequence of event functionality pertaining to the main protection applications shall be provided as a part of the individual protection devices. Sequence of event recording pertaining to the monitoring of non-protection device status information, such as switchyard open and close status which are not catered by the main protection relays, shall be recorded by the bay controller. The sequence of event recording shall: a) Have a time resolution of 1 millisecond or better. b) Be able to cope with up to 40 changes in any one 10 millisecond interval. c) The date and time should be printed to the nearest 1 millisecond followed by a tag describing the point which has operated. d) Events that occur while another event is in the process of being printed are to be stored for subsequent printing. Over 100 such events must be stored. The event printouts shall contain at least the station identification, date, and time (in hour, minutes, seconds and milliseconds), event number and event description (at least 40 characters).		
09.02.09	Synchronizing Check The built-in Synchronization Check feature shall determine the difference between the amplitudes, phase angles and frequencies of two voltage vectors. Checks shall be		
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9.02.10		provided to detect a dead line or bus bar. The voltage difference, phase angle difference and slip frequency settings shall be adjustable.	
		Transformer / Reactor Protection a) The Bay Protection Unit offered for each transformer/ Reactor should be such that it provides a comprehensive protection for the transformer/ Reactor for all types of faults and abnormal operating conditions. b) The numerical relays, comprising the Bay Protection Unit, for each transformer / reactor shall be configured into two protection groups operating on two separate DC supplies, such that one protection group shall always be available to detect and operate for any type of fault in the transformer/ Reactor, under condition of failure of other protection group or of associated DC supply of the other protection group. c) Should the protection functions specified for a transformer/ Reactor be available as a single discrete numerical relay, two such relays shall be supplied to meet the requirements of relevant clause above. Differential, REF and Back-up protection of any transformer/shunt reactor shall be realized in separate numerical relays with Differential, Back-up E/F in one channel and REF, Back-up O/C in another channel.	
9.02.10.01		Transformer/ Reactor differential protection shall: a) Be of numerical type and shall have continuous self-monitoring and diagnostic features b) Be three-pole type, with faulty phase identification/indication. The operating time of the relay shall not be greater than 30ms at 5 times the setting. c) Be stable for magnetizing inrush currents and shall be stable under normal over-fluxing conditions. Magnetizing inrush stability shall not be achieved using an intentional time delay. d) Have an internal feature in the relay to take care of the angle and ratio correction. e) Have a disturbance recording feature to record the analogue form of instantaneous values of the current in all three windings (i.e., nine analog channels) during faults and disturbances for the pre-fault and post-fault periods. The disturbance recorder shall have the facility to record the following external digital channel signals in addition to the digital signals pertaining to the differential relay itself: HV breaker (main and tie) status LV breaker status Buchholz/On-load tap-changer Buchholz alarm/trip Winding temperature/Oil temperature/Pressure relief alarm/trip of transformer f) The necessary hardware and software for downloading the data captured by the disturbance recording function to a personal computer available in the substation shall be included in the scope. g) Be acceptable with built-in features of definite time overload protection (alarm) relay provided the technical requirements of these relays specified under the relevant clauses are met.	
9.02.10.02		Restricted Earth Fault Protection shall: a) Be single pole type. b) Be of current/voltage operated high impedance type. c) Have a suitable non-linear resistor to limit the peak voltage	
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9.02.10.03	d) Shall have setting range from 5-80% Transformer/ Reactor over fluxing Protection shall a) Operate on the principle of voltage to frequency ratio b) Have inverse time characteristics compatible to transformer over fluxing withstand capability and a separate high set feature. c) Provide an independent alarm with continuously adjustable time delay. d) Tripping time shall be governed by V/ F Vs time characteristic of the relay e) Have a set of characteristics for various multiplier settings. f) Have a resetting ratio of 98% or better.		
9.02.10.04	Transformer/ Reactor Backup Over Current Protection (51) shall a) Be triple pole type b) Be of definite time over current type c) Have an adjustable setting range of 20-80% or 150-600% of rated current (as applicable) and 0.3 to 3.0 sec time delay. d) Be provided with operation indicator		
9.02.10.05	Transformer/ Reactor Backup Earth Fault Protection (51N) shall a) Be single pole type b) Be of definite time over current type c) Have an adjustable setting range of 10-80% of rated current as applicable and 0.3 to 3.0 sec. Time delay d) Be provided with operation indicator		
9.02.11	EHV Circuit-breaker Protection Each circuit breaker in the EHV switchyard shall be provided with following protection functions: i. Numerical Local Breaker Back up Protection Function: Duplicated LBB protection function shall be provided for each EHV circuit breaker in the EHV switchyard. The LBB protection function for each main circuit-breaker shall be interfaced with the Bus bar protection by hard-wired signals between the Bay Protection Unit and the Bus bar protection panels. The intent of providing the hard-wired logic as a back up to the software logic is to ensure that in the event of failure of Substation LAN, the bay level functionality is not hampered. The LBB function as a built-in function of Bay Protection Unit is acceptable provided it meets all the requirements specified for the LBB function. However, Tie LBB of incomplete dia shall not be realized not be realized as in-built function of BB protection. In addition, the LBB protection function shall meet following criteria: a) Be three pole type having three single phase units b) Shall operate for stuck breaker conditions c) Have an operating/resetting time each of less than 15 ms. d) The LBB function shall be initiated by external trip contacts from the Bay Protection Units and after a set time delay shall energize the trip bus in the bus bar protection scheme on which the stuck breaker is connected for tripping of all breakers		
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09.03.00	connected to the bus. For all EHV CBs, an instantaneous repeat trip command from LBB shall be given to the primary breaker through two separate self-reset trip relays on different DC source. e) Have a setting range of 5 to 80% of rated current f) Have a continuous thermal withstand of 2 times rated current irrespective of the setting. g) Have time delay feature with a continuously adjustable setting range of 0.1 to 1s. h) Shall be an individual phase comprehensive scheme. i) Shall not operate during the single-phase auto-reclosing period. j) Shall provide end-fault protection that initiates a direct transfer trip to the remote end. ii. Trip Coil Supervision: A Trip Coil supervision function shall be provided for each lockout trip relay and each of the circuit-breaker trip coils. It shall incorporate both the pre-close and post-close supervision of trip coils and associated trip circuits. An audible alarm shall be given in the event of operation of trip coil supervision function. It shall have a time delay on drop-off of not less than 200ms. Trip coil supervision function as a built-in feature of the BCUs / Bay Protection Units is also acceptable, provided it meets all other requirements specified here, including loss of DC supply. iii. High Speed Trip Relays supplied under this package shall be: a) With operating time of less than 10ms. b) With reset time of less than 20ms. c) Provided with operation indicator for each element/coil. d) Have adequate contacts to meet the scheme requirements of trip, interlock, LBB, auto-reclose, DR, fault locator, etc. e) Hand reset or self-reset, depending on the application. Further, the trip relays shall be provided with a feature to receive manual reset command from engineering workstation located in remote. Islanding Scheme Islanding scheme shall be provided for the 400kV switchyard as below: - i. An under frequency with df/dt based islanding scheme for the whole generating station shall be provided and shall be in the switchyard. ii. Shall employ two out of three channels of U/F and df/dt for high reliability for each bus. iii. Each of the three channels of under frequency islanding scheme shall be independent from each other, starting from the VT measuring core, control cables, dc supplies, under frequency or df/dt measuring relay, etc. till the islanding trip relay of the breaker. iv. Shall be a multi-step scheme and each step shall have setting range of + 5% to - 8% with timers of required setting. v. Shall have a separate dedicated islanding trip relay for each of the EHV breaker including all EHV bays and future bays as per switchyard SLD. vi. Separately fused 220V DC supplies shall be employed.
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10.00.00	Energy Meters		
10.01.00	One no. class 0.2s accuracy energy meters suitable for ABT requirement as specified below in clause 10.02.00 shall be provided at each location indicated in respective tender protection SLD. All ABT type meters shall be fed from accuracy class 0.2s CT and accuracy class 0.2 CVT/VT/PT. This metering system shall have following features: - Meters shall be microprocessor-based MWH meters having an accuracy class of 0.2S or better. MVARH meters shall have accuracy class of 0.5 or better. - These meters shall have provision for downloading of data through an optical port and /or through RS 232/485/ Ethernet port. - Even under absence of VT input, energy meter display shall be available, and it shall be possible to download data from the energy meters. - All these meters shall be networked using Modbus protocol and connected to the Metering Master Station (MMS), provided for the ABT meters. Dummy panels shall be supplied for mounting of owner's supplied energy meters. These energy meters shall be two (2) nos for each EHV line bay and one (1) no. for each generator /generator transformer bay /transformer bay /reactors bay. Terminal blocks (disconnecting type) shall also be provided with these panels. Quantity and dimension of these panels shall be decided during detailed engineering.		
10.02.00	Technical Requirements of Energy Meters for ABT Requirement Contractor shall supply energy meters along with metering station, 4 Nos. machine Clients, 20 nos web client license. MRI or lap top (as applicable) as per the technical specification given below: - Shall be microprocessor-based conforming to IEC 62052-11, IEC 62053-22, IS 14697 - Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase loads. - Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy. - The active and reactive energy shall be directly computed in CT & VT primary ratings. - The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.		
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	xiv. The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built-in long-life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Even under absence of VT input, energy meter display shall be available, and it shall be possible to download data from the energy meter. In case data downloading is not possible in absence of VT supply, meter with provision of 220V DC auxiliary supply shall be provided. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory. xv. Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software. The contractor shall supply the MRI and/or notebook complete with all optical interface unit required. xvi. A dedicated Metering Master Station (MMS), networked to all the energy meters in contractor’s scope shall be provided. The MMS shall be complete to offer the following functionality: a) To automatically/manually download the meter data from each meter point at scheduled daily intervals. Manual data download in MMS should not interfere with automatic real time data downloading. b) To create calculated metering points by addition, subtraction, and applying multiplication factors to meter points c) To present the demand of each meter point and calculated meter points in graphical format over specified intervals. d) To calculate the total energy exchanged on meter points or calculated meter points for different time-of-use periods over specified intervals. e) Modify ABT parameters as notified by CERC from time to time. f) To export meter data to Excel format for external analysis. g) Real time display of Generation data- Unit wise, and Station. h) Real time block wise generation data with SG, DC, Frequency, UI etc. unit wise, and station. i) Commercial report- day wise. j) Monthly commercial performance of station, stage wise and unit wise. k) Auto schedule update into server after schedule update in local file/folder of MMS. l) Data polling rate for each meter to be in the range of 3-5 sec. m) Cycle time of server to be less than 1 sec. n) Refresh rate of client screen to be less than 5 sec. o) Alert on non-commercial generation based on frequency, fuel cost etc.			
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11.00.00	Above features are indicative only. Reports and software features shall be submitted for review and approval during detailed engineering stage. xvii. The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same. xviii. Each meter shall have a unique identification code provided by the Owner and shall be permanently marked on the front of the meter and stored in the non-volatile memory of the meter. xix. The MMS shall be connected to substation LAN so as to facilitate display of energy data at other locations of the LAN and communication of these data to owner's Plant Information (PI) System on OPC. Time Synchronization Equipment i. Time Synchronization equipment shall be provided and shall be located one in the switchyard Control Room. It shall receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization of all components of the SAS/ generator relay panel. ii. Shall be complete in all respects including antenna, all cables, processing equipment, etc. iii. All auxiliary systems and special cables required for synchronization of the equipment shall be supplied and commissioned by the Contractor. iv. Shall work from DC supplies only and the Contractor to clarify if any built-in battery backup is provided, in which case, same shall be of long-life lithium batteries. v. Shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and over-voltages in power supply systems and antenna feeders. vi. The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255. One copy of all the test reports shall be enclosed with the bid. vii. All components of the SWYD SAS, including Substation Controllers, Workstations, Bay Control Units (BCU) and Bay Protection units (BPU) and all numeric protection relays shall be synchronized with an accuracy of 1ms. viii. The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals. ix. The system shall have provisions for combination of any of the following output signals: a) NTP (network time protocol) 100Mbps Ethernet port b) IRIG-B00x (TTL, pulse width modulated signal) c) 2 x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts d) Any other output port as may be required for the offered system. e) Alarm status contact indicating healthy status of system x. These output ports shall be compatible with the requirement of the equipment to be synchronized i.e., BCUs and BPUs. The master clock in control room shall also be synchronized with the time synchronization system. The actual port requirements
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	(no. /type) in line with the system offered shall be finalized during detailed engineering. xi. The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24-hour mode) and have a separate time display unit to be mounted on top of the MIMIC panel, having display size of approx. 144mm height.			
12.00.00	Relay Test Equipment i. The required relay test equipment shall comprise the following: a) One Dynamic portable relay test system for allowing dynamic and steady state testing of IEC 61850 compatible IEDS also. b) Any other auxiliary items like phantom loads, etc. required for testing all the protection relays supplied under this contract. ii. It shall have the capability to replay the Disturbance / Fault records acquired by the numerical relays / stand-alone DR in IEEE / COMTRADE format or EMTP simulations, to facilitate dynamic testing of all the numerical relays supplied under this contract. The required software for steady state/dynamic testing of all the numerical protection relays, energy meters and transducers, along with a laptop PC, shall also be supplied. i. All commissioning tests on protection relays, energy meters and transducers shall be carried out with this relay test equipment being supplied under this contract and test reports shall be maintained as per the agreed protocols.			
13.00.00	NIL			
14.00.00	Panels i. All panels shall be free standing, floor mounting type and completely metal enclosed. Cable entries shall be from the bottom. Panels shall be of IP 31 class or better. ii. Panels shall have removable gland plates with glands made of brass and shall be suitable for armoured cables. iii. Thickness of panel sides shall be 2mm for Cold Rolled Sheet Steel, 2.5mm for Hot Rolled Sheet Steel. iv. Panels shall be painted. The colour of paint for exterior of the panel shall be as follows: I. Ends: Colour- Blue, Shade- RAL5012 II. Front and Rear: Colour- Grey, Shade- RAL9002 i. Panels shall have a lockable front toughened glass door and a swing frame/ fixed rack. Panels shall facilitate direct access to any component mounted inside and shall have at least 20% free space for future expansion. ii. Shall be supplied complete with interconnecting wiring between all devices mounted therein. iii. All equipment mounted on front and rear side of the panels shall have individual name plates with equipment designation engraved. Each panel shall also have circuit/feeder designation name plate.			
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14.01.00		iv. Each panel shall be provided with a 240V AC fluorescent lighting fixture controlled by door switch as well as a 5A, 240V AC switch-socket unit. v. Shall be provided with necessary arrangements for receiving, distributing, isolating, and fusing of AC & DC supplies for various circuits for control, signalling, lighting, interlocking, etc. Selection of main and sub-circuit fuse rating shall ensure selective clearance of the sub-circuit faults. vi. Voltage circuits for protection and metering shall be protected by fuses. Suitable fuse failure relays shall be provided to give an alarm for voltage circuits of protection/metering. Voltage selection scheme based on relays shall be provided for meters wherever applicable. vii. The DC supplies at the individual relay and protection panels shall be monitored and failure of DC supplies shall be enunciated.		
		Earthing i. The panels shall be equipped with an earth bus of at least 50x6mm² galvanized steel flat bar or equivalent copper. ii. Earth buses of adjoining panels shall be connected for continuity. The continuous earth bus so formed shall be connected to the main earth grid at one end only. iii. All metallic cases of the mounted equipment shall be separately connected to the earth bus by 2.5mm² copper wires. No loops in the earth wiring shall be permitted. iv. CT/VT neutral secondary shall only be earthed at the terminal block of the panel through links, such that the Earthing of one group may be removed without disturbing others. v. An independent Electronic Earth System shall be provided as per contractor's standard. The electronic earth shall be connected to the substation earth mat through a dedicated riser.		
14.02.00		Panel Wiring i. Internal wiring to be connected to external equipment shall terminate on terminal blocks. ii. The terminal blocks for CTs and VTs shall be provided with test links and isolating facilities. The CT terminal blocks shall be provided with short circuiting and earthing facilities. iii. Shall have 20% terminals as spare terminals in each panel. iv. All equipment mounted on front and rear side of the panels shall have individual nameplates with equipment designation engraved. Each panel shall also have circuit/feeder designation name plate. v. All wiring shall be with 1100 V grade, single core, PVC insulated stranded copper conductor. 1100V grade Terminal Blocks shall be provided. vi. Wires shall be vermin proof. Minimum size of conductor shall be 1.5 mm² in general, but for CT & VT circuits it shall be 2.5 mm². Minimum number of strands shall be three. vii. Contractor shall be solely responsible for completeness and correctness of all the wiring, and for proper functioning of the connected equipment.		
15.00.00		Control Cabling Philosophy in Switchyard i. Each secondary core of all the phase CT/CVT shall be brought to the equipment marshalling box through independent cables.		
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16.00.00 16.01.00 16.02.00	h) Necessary interconnections from transformer MB to RTCC / BCU (located in SWYD Control Room) for OLTC control & monitoring. i) Any screened cable required for connecting 4-20 mA analog signals. j) Necessary cabling between Transformer / Reactor MB and SWYD Control Room for various Transformer / Reactor monitoring system and fire protection system. k) Necessary interconnections for signal exchange between SWYD / SWYD CR to interfacing panels of RLDC, DCS and PMU. vii. Spare cores shall be provided as per following norms: a) Up to 3-core cable – 1 core b) 5 Core Cable - Min. 1 core c) 7 to 14 core cables - Min. 2 cores d) More than 14 core - Min. 3 cores Factory Acceptance Tests (FAT) All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the contractor and Owner's representatives during manufacture, erection and on completion. The approval of the Owner or passing such inspections or tests will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service. The detailed requirement of operational and pre-FAT tests as well as FAT test (Integrated Test) is given in this Section. The FAT shall be mutually agreed upon and approved by Owner during detailed engineering. Operational and Pre-FAT Tests i. The authorized quality assurance personnel of the contractor shall conduct all tests as per the requirements of this clause 15.02.00 and clause 15.03.00 and fully satisfy themselves regarding completeness of hardware, software, and full compliance with specification requirements by all equipment/sub-systems and the system as a whole before sending notification for FAT to the Owner. Contractor shall maintain accurate records for all pre-FAT tests which shall be properly documented, and duly certified documents shall be furnished to Owner at least two weeks prior to FAT tests, while giving inspection call. ii. Each individual item of equipment/ sub-system/ software package furnished by the Contractor as well as the complete system as per this specification shall be inspected and tested by the Contractor in his works for full compliance with specification requirements, completeness, proper assembly, proper operation, cleanliness, and state of physical condition as applicable. ii. The Contractor shall conduct a point-by-point wiring continuity check to every input and output and verify that the wiring connections agree with the documentation. iii. Contractor shall conduct all tests as per requirements of clause 15.03.00 (Factory Acceptance Tests) to fully satisfy himself regarding completeness of the system and full compliance with specification requirements for SAS as a whole as well as for individual components/ software module. This test will be done for 100% samples, even if the FAT requires tests for only some smaller percentages.
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16.03.00	iv. The pre-FAT report shall be in the format of FAT procedure as approved by the Owner. It shall be accompanied by a very detailed report, in a log form, of the performance of all pre-FAT Tests. These records shall list not only the successfully completed tests, but shall detail all system, test and component failures.		
16.04.00	Notification for FAT		
	Factory Acceptance Tests (FAT)		
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	Owner approved format as decided during detailed engineering and submitted in the requisite number of copies with all annexes irrespective of the fact that Owner's representative was present during the tests. iv. For integrated testing of the total SAS system, the Contractor shall provide an I/O generator/simulator, which will be connected, to the BCUs simulating the plant status and plant operation. This will help in generating desired rate and sequence of I/O to test various BCU and HMI functionality under worst case loading conditions. With the I/O generator/simulator, all possible interlocking conditions shall be simulated, and controls tested. v. Following the tests, if in the opinion of the Owner, the system has not been adequately manufactured, programmed, tested, or debugged the Contractor shall make good all deficiencies including system parametric specifications of display response time, processor duty cycle, SOE resolution, etc., and re-run the test to fully satisfy the Owner regarding full compliance with specification requirements and requisite quality standards. The Contractor shall be responsible for all travel and accommodation costs of the Owner related to re-visits and/or re-testing required. vi. The system shall not be shipped without approval of Owner in writing. Upon successful completion of FAT, the Owner will provide the Contractor with a written authorization for shipment of the system equipment to the project site. vii. Contractor shall note that no payments towards dispatch of equipment and subsequent activities shall be due and payable to the Contractor till the Contractor is able to successfully demonstrate to Owner's satisfaction that the SAS and parts thereof fully meet the FAT requirements. viii. The tests shall include the verification of all I/O functions at all Control Levels. The interface to the control center(s), interface to the EHV SAS and interface to the DDC shall be tested with the use of a protocol simulator. viii. Performance test: The duty cycle time as specified in <u>clause 3.02.00</u> shall be checked under the worst loading conditions. 17.00.00 Site / Commissioning Tests 17.01.00 Site tests shall include all tests to be carried out at site upon receipt of equipment. It shall include but not be limited to testing calibration, configurations and pre-commissioning trials start up tests, trial operation and performance and guarantee tests. The Contractor shall be responsible for all site / commissioning tests. 17.02.00 The Contractor shall maintain all tests, calibration records in Owner approved formats, and these shall be countersigned by authorized quality assurance personnel of the Contractor supervising these works. 17.03.00 The Contractor shall maintain master checklists to ensure that all tests and calibration for all equipment/devices furnished under these specifications are satisfactorily completed under the supervision of the authorized quality assurance personnel of the Contractor. 17.04.00 The site / commissioning tests shall be categorized under following categories: i. Start-up tests ii. Calibration and configuration checks iii. Pre-commissioning tests iv. Trial Operation
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17.05.00	v. Availability Tests		
17.06.00	Point-to-point testing of all the I/O signals in the EHV network.		
	Point-to-point testing shall include:		
	i. Verification of all status indications by operating the plant		
	ii. Verification of event / alarm indications by simulating alarm conditions		
	iii. Verification of all analogue indications by injection testing		
	iv. Verification of all controls by operating the plant		
17.07.00	Availability Tests		
	i. The Contractor shall guarantee 99.9 percent availability for a continuous period of 1000 hrs. Availability guarantee test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.1% of 1000 hrs, during availability test run, a new 1000 hrs test run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the systems guaranteed accuracy and repeatability or of any system function, except however, that the loss of a function for not more than five percent of the points shall not be considered loss of availability. Loss of function for not more than 5% of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to the function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripherals device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeatability and system parametric requirements specified in clauses on system parametric requirements shall be maintained for the entire 1000 hrs run without any manual re-calibration or any other changes made to the SAS.		
	ii. Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.		
	iii. The Contractor shall submit the Availability Test Procedure for Owner's approval. The details regarding outage time, weighing factors for various systems functions equipment to calculate the down time shall be discussed and finalized during detailed engineering.		
	iv. The availability test shall start at a date, which will occur, between the commissioning date and 5 months after commissioning. The contractor will be notified the date during PG test.		
	v. The availability test shall be expressed as percentage, which shall be calculated as $(100\% \times (\text{test duration time} - \text{Accumulated test outage time} / \text{Test duration time}))$.		
	vi. System outage time will be accumulated over test duration and calculated as outage time x weighing factor. The contractor shall submit a list of weighing factors for all system components along with the bid and the same will be mutually finalized before contract award. Outage time shall be weighted by each function's weighing factor.		
17.08.00	Conditions for Availability Tests		
	i. Down time shall start with the notification to contractor about any loss of function. Downtime shall be exclusive of travel time required by the Contractor, but not in excess of 8 hours.		
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17.09.00		ii. The contractor shall furnish in his bid recommended spare parts inventory, along with unit price, to be maintained at site during availability test run. If the spare parts required for maintenance as recommended by contractor are not available with Owner for fault repair the outage time necessary for obtaining spare will not be counted. If the required spare is not recommended by the Contractor and are required for repairs, then the time required to obtain the part by the Contractor shall be multiplied by weighting factor or 0.05 and counted as a accumulated outage time. The spare parts, which are used by the Contractor and not replaced by the contractor, shall accumulate outage time at the rate of time required to obtain the spare parts multiplied by the weighing factor of 0.05 if the part is required on a subsequent outage.								
		iii. The contractor shall be responsible for replacing any of the Owner’s spare parts which are used in the availability run free of cost to the Owner.								
		iv. Failure of peripheral output devices shall be counted as outage time if failure of the device affects any for part of the system function.								
		v. Any degradation of function shall accrue outage time regardless of processor configuration.								
		vi. During a period of system outage, the Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Contractor.								
18.00.00		vii. Should the contractor determine that partial use of the system by the Owner will interfere with the contractor’s maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to the Owner. This shall include offline servicing.								
		ii) Outage time for each function shall stop at the time the contractor returns each of the functions in full service and relinquishes full use of the system to the Owner.								
		The contractor shall prepare a detailed site / commissioning tests procedure based on the guidelines given here and submit to Owner for approval during detailed engineering stage.								
		System Hand-over and Final Acceptance								
		i. The system will be handed over to the Owner for commercial operation after the site / commissioning tests have been completed to the satisfaction of the Owner. A hand-over certificate will be issued by the Owner. The Contractor will still be responsible for the Availability Tests.								
18.01.00		ii. Final acceptance of the system by the Owner will take place after the Availability Tests have been done to the satisfaction of the Owner.								
		Type Test Requirements								
		Test reports for following type tests shall be submitted for all BCUs / BPU’s / DR. Reports / Certificates of tests conducted in accredited Laboratories (accredited by the national accrediting body of the country where the lab is located) are also acceptable.								
		BCU/BPU								
		i. Insulation Tests								
18.01.01		<table><tr><th>Sl.No.</th><th>Description</th><th>Standard</th></tr><tr><td></td><td></td><td></td></tr></table>			Sl.No.	Description	Standard			
		Sl.No.	Description	Standard						
400KV SWYD AT SCCL		TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-37 OF 42						

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CLAUSE NO.																		
	<table><tr><td>1.0</td><td>Dielectric Tests</td><td>Withstand</td><td>IEC 60255-27 ed2.0 2kV rms for 1 minute between all case terminals connected together and the case earth. 2kV rms for 1 minute between all terminals of independent circuits with terminals on each independent circuit connected together. ANSI/ IEEE C37.90 1kV rms for 1 minute across the open contacts of the watchdog relays. 1kV rms for 1 minute across open contacts of changeover output relays. 1.5kV rms for 1 minute across open contacts of normally open output relays.</td></tr><tr><td>2.0</td><td>High Voltage Impulse Test, class III</td><td></td><td>IEC 60255-27 ed2.0 5 kV peak; 1.2/50 μsec; 0.5 J; 3 positive and 3 negative shots at intervals of 5 sec</td></tr></table>			1.0	Dielectric Tests	Withstand	IEC 60255-27 ed2.0 2kV rms for 1 minute between all case terminals connected together and the case earth. 2kV rms for 1 minute between all terminals of independent circuits with terminals on each independent circuit connected together. ANSI/ IEEE C37.90 1kV rms for 1 minute across the open contacts of the watchdog relays. 1kV rms for 1 minute across open contacts of changeover output relays. 1.5kV rms for 1 minute across open contacts of normally open output relays.	2.0	High Voltage Impulse Test, class III		IEC 60255-27 ed2.0 5 kV peak; 1.2/50 μsec; 0.5 J; 3 positive and 3 negative shots at intervals of 5 sec							
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400KV SWYD AT SCCL	TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-38 OF 42

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CLAUSE NO.																													
		<table><tr><td>5.0</td><td>Fast Transient Disturbance</td><td>IEC 60255-26 ed3.0, class IV 4kV, 2.5kHz applied directly to auxiliary supply 4kV, 2.5kHz applied to all inputs.</td></tr><tr><td>6.0</td><td>Surge Withstand Capability</td><td>IEEE/ANSI C37.90.1 4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input and power supply circuit.</td></tr><tr><td>7.0</td><td>Electrostatic Discharge</td><td>IEC 60255-26 ed3.0 Class 4 15kV discharge in air to user interface, display and exposed metal work.</td></tr><tr><td>8.0</td><td>Surge Immunity</td><td>IEC 61000-4-5 Level 4 4kV peak, 1.2/50ms between all groups and case earth. 2kV peak, 1.2/50ms between terminals of each group.</td></tr></table> iii. EMC Tests: <table><tr><th>Sl.No.</th><th>Description</th><th>Standard</th></tr><tr><td>1.0</td><td>Radiated Immunity</td><td>C37.90.2 25MHz to 1000MHz,</td></tr><tr><td>2.0</td><td>Radiated Electromagnetic Field Disturbance Test</td><td>IEC 60255-22-3 80-1000 MHz, Amplitude Modulated</td></tr><tr><td>3.0</td><td>Disturbances Induced by Radio Frequency fields, Amplitude Modulated (Conducted Immunity)</td><td>IEC 60255-22-6 150kHz – 80 MHz;</td></tr><tr><td>4.0</td><td>Power Frequency Magnetic Field</td><td>IEC 61000-4-8 ed2.0, class IV</td></tr></table>	5.0	Fast Transient Disturbance	IEC 60255-26 ed3.0, class IV 4kV, 2.5kHz applied directly to auxiliary supply 4kV, 2.5kHz applied to all inputs.	6.0	Surge Withstand Capability	IEEE/ANSI C37.90.1 4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input and power supply circuit.	7.0	Electrostatic Discharge	IEC 60255-26 ed3.0 Class 4 15kV discharge in air to user interface, display and exposed metal work.	8.0	Surge Immunity	IEC 61000-4-5 Level 4 4kV peak, 1.2/50ms between all groups and case earth. 2kV peak, 1.2/50ms between terminals of each group.	Sl.No.	Description	Standard	1.0	Radiated Immunity	C37.90.2 25MHz to 1000MHz,	2.0	Radiated Electromagnetic Field Disturbance Test	IEC 60255-22-3 80-1000 MHz, Amplitude Modulated	3.0	Disturbances Induced by Radio Frequency fields, Amplitude Modulated (Conducted Immunity)	IEC 60255-22-6 150kHz – 80 MHz;	4.0	Power Frequency Magnetic Field	IEC 61000-4-8 ed2.0, class IV
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400KV SWYD AT SCCL		<table><tr><td>TECHNICAL SPECIFICATION</td><td>PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM</td><td>PAGE E-1-39 OF 42</td></tr></table>	TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-39 OF 42																								
TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-39 OF 42																											

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CLAUSE NO.												
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	iv. Atmospheric Environment Tests:											
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	v. Mechanical Stress Tests:											
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3.0	Seismic Vibration (during Operation)	IEC 60255-21-3										
vi. Conformance Testing												
18.01.02 ENERGY METER All type test reports as per IEC 62052-11/IEC 62053-22												
18.01.03 DISTURBANCE RECORDER Type test reports for the following tests shall be submitted												
i. High Voltage Impulse Test, class III as per IEC 60255-27 ed2.0 ii. High Frequency Disturbance as per IEC 60255–26 ed3.0, class III iii. Fast Transient Disturbance as per IEC 60255-26 ed3.0, class IV												
400KV SWYD AT SCCL	TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-40 OF 42									

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CLAUSE NO.													
18.01.04	NA												
18.02.00	Functional Tests All the numerical relays shall be tested for the functions specified in SCCL technical specifications. In case of Numerical Distance Relays, test reports for dynamic tests clearly indicating the operating time under different system / fault conditions shall be submitted.												
19.00.00	Settings Fault levels will be provided to the Contractor by the Owner. The Contractor shall, based on this information, compile a complete and detailed report for the setting of the protection elements on all the protection equipment, to the approval of the Owner. Any additional information required to complete this exercise shall be timely requested by the Contractor. The contractor shall provide the Owner with a philosophy document clearly setting out the philosophy the contractor will use in determining setting levels. Each setting will have a brief description of the specific function or element. The setting calculation and formula will also be shown on the document. All relevant system parameters, transformer data additionally used for calculating the setting will appear in the setting document. The contractor will conduct system studies in determining fault levels on different locations. These study results will also form part of the setting document. Any additional information required to complete this exercise shall be timely requested by the Contractor. The setting document will be presented and discussed with the Owner prior to final issue of the document. The final accepted setting document should be made available to the Owner in PDF format. It is the Contractor's responsibility to configure each protection relay to provide the protection and control facilities required. A full set of relay configuration and setting files shall be included in the design and documentation submissions. The contractor will issue three sets of setting documents once accepted by the client and consultant.												
20.00.00	Furniture The furniture required for the officials/ operators & for locating the various items in the control/ relay room shall be supplied. The exact requirement/ details shall be finalized during detail engineering. However, a minimum requirement is specified below: <table><tr><td>i)</td><td>Desk for Switchyard control room – Modular) & Desk (Size for 01 workstation and printer) for workstations and printers covered under this package</td><td>5</td></tr><tr><td>ii)</td><td>Chairs</td><td>10</td></tr><tr><td>iii)</td><td>Filing Cupboard</td><td>2</td></tr><tr><td>iv)</td><td>Desk(modular) for SWYD CR</td><td>1 set</td></tr></table>	i)	Desk for Switchyard control room – Modular) & Desk (Size for 01 workstation and printer) for workstations and printers covered under this package	5	ii)	Chairs	10	iii)	Filing Cupboard	2	iv)	Desk(modular) for SWYD CR	1 set
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400KV SWYD AT SCCL	TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-41 OF 42										

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400KV SWYD AT SCCL	TECHNICAL SPECIFICATION	PART-II SECTION – VI SUBSTATION AUTOMATION SYSTEM	PAGE E-1-42 OF 42



SUB-SECTION-B – 14

ELECTRICAL WORKS FOR CHIMNEY

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	CHIMNEY ELECTRICAL WORKS			
1.00.00	GENERAL REQUIREMENTS			
1.01.00	This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A.			
1.02.00	For specification requirement of electrical equipment and accessories such as DB, cable, cabling, lighting, earthing, lightning protection etc., contractor shall refer relevant chapters of this Technical specification in addition to following clauses mentioned in this document.			
1.03.00	The equipment shall be suitable for installation and render trouble free & continuous operation at higher ambient temperature and rigorous weather conditions prevailing at chimney. Ambient temperature for design of all equipment shall be considered as 55 degrees C.			
1.04.00	The electrical equipment/installations shall comply with the requirements of the following Rules/ Regulations as amended up to date: i) The Indian Electricity Rules/Acts. ii) National Electrical codes and Indian standards. iii) International Civil Aviation organisation Regulations. iv) National Airport Authority/DARA Regulations.			
1.05.00	Main distribution board & emergency distribution board shall be located at chimney base. Main DB shall be 415V, 3ph 4 wire and Emergency DB shall be 415 volt, 3 phase, 3 wire. Emergency DB will receive one feeder from Emergency power supply feeder and one feeder from main distribution board. Contractor shall provide auto-change over supply to healthy source on failure of any source. In case any power supply other than 415 V, 3 phase indicated above is required, the transformation for same shall be included in the Contractor's scope of work.			
1.06.00	Elevator Board shall be of metal enclosed, single front, indoor, floor mounted, free standing, fixed type conforming to IS 13947-PART-I. The Elevator board & Power panels shall be of floor/wall mounted type. The equipment shall be supplied fully assembled and wired, complete with base frame and anchoring arrangement, gland plates, internal wiring, terminal blocks and suitable for termination of external power and control cables. Overall height of Board shall not exceed 2450 mm. All board frames and load bearing members 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. The gland plates thickness shall be 3.0 mm (minimum) for hot/cold-rolled sheet steel and 4.0 mm (minimum) for non-magnetic material. All panels shall be dust and vermin proof.			
1.06.01	The Board shall be divided into distinct vertical sections, each comprising of : i) A completely enclosed busbar compartment for running horizontal and vertical busbars. ii) Completely enclosed switchgear compartment(s) one for each circuit of outgoing feeder.			
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159-C-O-M-001	SUB-SECTION-B-14 ELECTRICAL WORKS FOR CHIMNEY	PAGE 1 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	iii) A cable alley for power and control cables of 250 mm width. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations in cable alley shall be designed to meet Form IVb Type & (as per IEC 60439) for safety. The front of the compartment shall be provided with hinged single leaf door with locking facility.			
1.06.02	Boards shall be provided with phase & neutral busbars along entire length of board. The minimum air clearance between live parts shall be 25mm for busbars and 10mm elsewhere both for phase to phase and phase to earth. Wherever such clearance is not available, the live parts shall be fully insulated/shrouded. However, for busbars minimum 25mm air clearance shall be maintained irrespective of insulated/shrouded busbars are provided.			
2.00.00	Lighting System			
2.01.00	The lighting system shall provide adequate illumination at various platforms, stairways, landing and other areas of the chimney.			
2.02.00	The following average illumination levels shall be achieved and guaranteed by the contractor after considering maintenance factor of not more than 0.6 :			
	a)	On equipment	150 Lux	
	b)	General platform area	70 Lux	
	c)	Stairways and landings	100 Lux [minimum one (1) light fixture at each landing].	
2.03.00	Power supply for normal lighting system shall be obtained through main distribution board. 80% lighting at various platforms and 50% lighting in staircases shall be fed from normal A.C. source. 20% lighting at various platforms and 50% lighting on staircases shall be fed from emergency distribution board.			
2.04.00	3 Pin Receptacles designed for IP:55 degree of protection shall be provided at every platform level, rated for 20A, 240 V,AC. The Receptacles shall be complete with 20A, 240V, AC switch and 3 pin plug.			
2.05.00	Heavy duty welding Receptacle rated for 415V, AC, 63A shall be provided at each internal platform level.			
3.00.00	Aviation obstruction lighting system			
3.01.00	Aviation obstruction lighting system shall conform to the requirements of the latest applicable rules of International civil aviation organization (ICAO) and NAA/DARA regulations.			
3.02.00	The aviation obstruction lighting system shall be of high intensity type.			
3.03.00	Photo electric controller shall be housed in rugged weather tight, IP 65 enclosure. LED's shall be provided to indicate the operation status of the unit.			
3.04.00	System controller shall be suitable for operation at specified ambient temperature and shall be wall mounted type. The enclosure shall have IP:55 degree of protection.			
3.05.00	Aviation obstruction light unit shall provide easy access to lamp and components.			
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159-C-O-M-001		SUB-SECTION-B-14 ELECTRICAL WORKS FOR CHIMNEY
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CLAUSE NO.	TECHNICAL REQUIREMENTS										
3.06.00	Four nos. of obstruction lights shall be installed at each specified elevation. The system controller is proposed to be located at 1.2 metre elevation and photo electric controller at about 40 metre elevation. Necessary cables for wiring between photocell & system controller and between system controller & obstacle lights shall be provided. Typical aviation obstruction lighting system arrangement is shown in the enclosed tender drawing.										
3.07.00	Each item shall be preassembled, routine tested optically and electrically before shipment.										
3.08.00	Bidder shall furnish the complete routine test report of the fixtures, controllers, photocells etc. Testing of aviation lights as per ICAO regulations to be carried out and routine test report to be submitted.										
3.09.00	High intensity obstacle lights shall meet the following requirements. (a) It shall be flashing white light. The effective intensity of obstacle light shall be variable and dependent on background luminance as follows. <table><tr><th>Background luminance</th><th>Effective Intensity</th></tr><tr><td>(i) Above 500 cd/m2</td><td>200000 cd ± 25% cd</td></tr><tr><td>(ii) 50 to 500 cd/m2</td><td>20000 ± 25% cd</td></tr><tr><td>(iii) Less than 50 cd/m2</td><td>4000 ± 25% cd</td></tr></table> (b) The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute. (c) The system shall also provide automatic sensing and display of system status and aviation lamp failure detection.	Background luminance	Effective Intensity	(i) Above 500 cd/m2	200000 cd ± 25% cd	(ii) 50 to 500 cd/m2	20000 ± 25% cd	(iii) Less than 50 cd/m2	4000 ± 25% cd		
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(iii) Less than 50 cd/m2	4000 ± 25% cd										
3.10.00	The distance between lighting elevations shall not be more than 105 Metre and lowest lighting elevation shall not be less than 70 metre.										
3.11.00	The light unit shall have adjustable bracket with level indicator to ensure accurate vertical placement of the light flash.										
3.12.00	Temporary obstruction lighting shall be provided during construction. Obstruction lights shall be provided on the uppermost part of the chimney, or the surrounding scaffolding. As construction progresses each completed level shall be provided with temporary lighting. Temporary obstruction lights shall have four fixtures located in a horizontal plane on the chimney structure to ensure unobstructed visibility of at least one obstruction light from aircraft at any normal angle of approach. Power for operation of the temporary obstruction lights shall be obtained from the construction power system. Supply circuit for these lights shall be furnished, installed and maintained by the Contractor. Temporary obstruction lights shall be operated from sunset to sunrise during each day of the contract period until such time as the Engineer issues instructions in writing to discontinue.										
4.00.00	Earthing										
4.01.00	Earth grid system for chimney shall consist of horizontal conductors and vertical conductors. Horizontal conductor shall be of 40mm dia mild steel rod buried at a depth of 1 metre all around the chimney. Vertical rods shall be of 40 mm dia, 3 metre long mild steel driven deep in to the ground and also connecting to horizontal conductor at 20 metre interval. The chimney earth grid system shall be interconnected with main plant earth grid at minimum 2 points, through bolted removable link and earth pits.										
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159-C-O-M-001	SUB-SECTION-B-14 ELECTRICAL WORKS FOR CHIMNEY								
			PAGE 3 OF 5								

CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.02.00	Metallic enclosures of all electrical equipments shall be earthed by two separate and distinct connections to earth grid system. The earth connections shall consist of galvanised steel strip/rod/wire, sized adequately to carry the earth fault current of the system. Two nos. main earthing conductor shall be run inside all along chimney height. Electrical equipments at every platform shall be earthed with this conductor. Cable armour shall be bonded to earthing system at both ends of the circuit. The earthing conductors and accessories located at top 12m level shall have lead cover of minimum 2mm thickness. The accessories like nuts, bolts, dash fasteners, round clamps, washers etc. to be used for top 12m level shall be made of stainless steel.		
4.03.00	Steel structures, metallic pipes etc. shall also be connected to earthing system. Connections between earthing conductor and equipments shall be of bolted type only. Earthing conductors along their run on walls shall be supported by cleating at 1 metre interval. Clamps and hardware shall be of compatible material. Minimum size of earthing conductor shall not be less than 14 SWG G.S wire. Earthing conductor shall also be run along with cable ways / each conduit run.		
4.04.00	The contractor shall provide and maintain a temporary earthing system until permanent earthing system is installed.		
5.00.00	Lightning Protection System		
5.01.00	Lightning protection system shall conform to IEC:60203. It shall comprise vertical air termination, horizontal air termination, down conductor, test links, earth connections and earth electrodes.		
5.02.00	Vertical air termination shall extend 3 metre above the top of the chimney. For each flue duct, 3 nos. vertical air terminations shall be provided. Vertical air termination shall be of 20mm dia copper rod with lead cover of 2 mm thickness.		
5.03.00	Horizontal air terminations(coronal bond) shall be of minimum 50x6 mm galvanised steel strips provided at following levels. a) Top level of each flue b) Roof top level around outer concrete shell c) Mid height around concrete shell		
5.04.00	Horizontal air terminations and vertical air terminations shall be inter connected by down conductors. No. of down conductors shall be minimum 4, equally spaced around and on exterior surface of concrete shell. Down conductors shall be of minimum 50x6 mm galvanised steel strip. Down conductors shall additionally be connected to vertical reinforcement rods at top and bottom of chimney at minimum four locations. Suitable precaution shall be taken at these joint connections to prevent any galvanic action. Reinforcement bars shall be made electrically continuous throughout their height.		
5.05.00	Each down conductor shall be provided with a test link at 1 metre above ground level. Each test link shall be enclosed in a galvanised sheet steel enclosure.		
5.06.00	Below the test link, direct connection with 40 mm dia mild steel rod shall be made to the earth grid system. Adequate no. of vertical electrodes of 40mm dia mild steel shall be provided to obtain required earth resistance.		
5.07.00	Down conductors shall not be connected to other earthing conductors above ground level. To avoid side flashing, metallic structures like hand rails, stairs etc.in the vicinity of down conductor shall be bonded to lightning protection system.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS	
5.08.00	Air terminations, down conductors, coronal band and accessories located at top 12 m level shall have lead cover of 2mm thickness. Suitable bimetallic washers shall be used while connecting conductors of different materials. The accessories like nuts, bolts, dash fasteners, round clamps, washers etc., to be used for top 12 metre level shall be made of stainless steel.	
5.09.00	Down conductors and horizontal air terminations shall be cleated to concrete structure at 750 mm interval.	
5.10.00	The contractor shall provide and maintain a temporary lightning protection system until permanent lightning protection system is installed.	
6.00.00	Communication system	
6.01.00	Contractor shall provide telephone cable installed in independent G.I. conduits and wired up to junction boxes with telephone socket at 0.0 M and at every internal platform for connection of telephone handset.	
6.02.00	Telephone cables shall be of minimum 0.6 mm dia annealed high conductivity electro copper conductor, PVC insulated, twisted, PVC tape wrapped, screened, rip corded, PVC sheathed, conforming to relevant ITD (Indian Telephones Department) specifications.	
7.00.00	TESTS	
7.01.00	All equipment to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all type tests as listed below: (A) Distribution boards/panels-Degree of protection tests (B) Aviation lights: (1)Intensity Test (2)Degree of protection test (3)Dust Ingress test	
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SUB-SECTION-B – 15

ELECTRICAL HOIST, CRANE AND ELEVATOR

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<u>ELECTRICAL HOIST, CRANE AND ELEVATOR</u>			
1.00.00	CODES AND STANDARDS			
1.01.00	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the standards/ codes as applicable.			
2.00.00	Electric motor: The driving motors shall conform to IEC 60034 and suitable for the Variable Voltage Variable Frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415V (+/- 10% variation) , 3 phase, 3 wire, 50HZ (+3% to -5% variation) supply. Motors shall be provided with thermal class 130(B) or better insulation			
3.00.00	CAR ELECTRICAL ACCESSORIES The following accessories shall be provided: a. LED light fittings for illumination level of 100 lux on car floor. b. Portable light and alarm bell with battery and charger ventilation fan with control. c. Car control station with position indicator inside the car and at landing platforms(both visual and audio). d. Emergency stop switch. e. 5/15A,3 pin plug socket with switch on top of lift car. f. Hand free speaker telephone set connected to plant network. g. AUTOMATIC RESCUE DEVICE (ARD)- (BATTERY DRIVE) : Contractor to provide a modern Advanced electronic drive system of “RESCUING Passenger Trapped in an ELEVATOR”. h. EMERGENCY SAFETY DEVICES: The lift shall be provided with safety Device attached to the lift car frame and placed beneath the car. The safety device shall be capable of stopping and sustaining the lift car up at governor tripping speed with full rated load in car.			
4.00.00	OPERATIONAL REQUIRMENTS: a. Contractor shall provide car operating panel with luminous buttons, car position indication in car (both visual and audio) combined with direction arrows, overload warning indicator, battery operated alarm bell and emergency light and fan & hands free speaker telephone set with suitable battery, charger & controls. b. Contractor shall provide emergency indicator to indicate the location of elevator in case of elevator being stuck up between the floors through automatic flashers (both audio & visual).			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	c. Contractor shall provide electronic door detector (Infra-red curtain type). d. Digital hall position indicator at all floors, tell lights at all floors shall also be provided by the Contractor. e. For facilitating the movement of visually & hearing-impaired persons, hall lantern and car arrival chimes shall be provided f. All fixtures shall be in stainless steel face plates. g. Push buttons shall be fixed in the car for holding the doors open for any length of the time required. h. All other safety/protection/operation interlocks as required by IS:14665 (latest edition).			
4.00.00	POWER SUPPLY: Each elevator shall be provided with a separate three phase, three wire 415V feeder of adequate rating			
5.00.00	Controls: The controls shall be Variable Voltage and Variable frequency type and shall provide smooth and constant acceleration and retardation under all conditions of operation. Suitable control panel shall be provided in the machine room.			
6.00.00	Cables and wiring: All the cables except trailing cables shall be as per IS:1554-1 or IS-7098-I. The PVC outer sheath of these cables shall be flame retardant, low smoke (FRLS) type with the following FRLS properties. a) Oxygen index of min. 29 (as per IS:10810 Part-58) b) Acid gas emission of max. 20% (as per IEC-754-I). c) Smoke density rating shall not be more than 60% (as per ASTM-D-2843). The circular trailing cables shall be either in accordance with IS 4289 Part-I (Elastomer insulated) or IS-4289 Part-II (PVC insulated). The flat type of trailing cables if offered shall be in accordance with IEC-60227-6. All wiring / cabling between the equipment's in the lift machine room and that between the machine room and equipment's in the lift well and at the landings shall be wired in HDPE conduits/ galvanized steel conduits to be supplied by the contractor. Alternatively armored cables may be used.			
7.00.00	Earthing: The elevator, EOT and crane structures and all Electrical equipment, including metal conduits shall be effectively earthed with the earth conductors provided in the machine room as per IS: 3043.			
8.00.00	EOT/ Hoist and Crane Motors: Three phase Squirrel Cage Induction motors to be operated from VFD system shall be suitable for speed range and torque without exceeding temperature rise limits as specified elsewhere in this specification. These motors shall be provided with VPI insulation and insulated bearing on one side for motor frame size above 250 frame and shall be suitable for			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.01.00	Inverter duty. However, contractors proven practice with respect to the use of insulated bearing in VFD driven motor may be accepted subjected to Employers approval. Motors shall conform to latest revision of IS 12165/IEC 60034, IS 3177 and motor subsection of this specification. Controls: a) Speed control of EOT crane shall be through Variable Voltage Variable Frequency System (VVVF) with minimum 6 (six) pulse design. b) Necessary input & output devices to be provided to reduce harmonics, as per IEEE519, at supply side of the drive at the switchgear. c) All necessary protections e.g., Input Phase Loss, Earth Fault, Over Voltage, Output Short Circuit, Load Loss, Input Transient Protection, overload etc to be provided. d) VVVF system shall be capable of generating suitable starting torque (up to 400% typical) with / without encoder, however starting current shall not exceed 150% at rated torque. e) VVVF system shall be capable to withstand up to 50 deg C ambient temp without derating. f) Provision for controlling the motion from operator cabin (in case of Turbine Hall EOT crane) as well as remote control shall be available. g) Squirrel cage Induction motor with VPI insulation shall be provided With VVVF system. h) Master controller - Desk type having following features. I. Five speed control points in each direction of hoist motion. II. Four speed control points in each direction of bridge and trolley motion. III. Release of operator's hand from the controls shall stop motion and set brakes automatically. i) Protective Panel: Shall be Provided with isolating switch, power contactor control and indication to switch ON/OFF power to starter panels, control and lighting transformer. j) Starter Panel: I. Separate VVVF system panels to be provided for CT, LT and hoist motion (main and auxiliary drives). II. Contactors shall be of AC 4 duty for reversing application and AC 3 duty for non-reversing application III. Switches shall be AC 23 for motor application and AC 22 for other application. IV. Fuses: HRC V. Overload relay shall be of Temperature compensated, bimetallic with single phasing preventor. k) Panel shall be fabricated out of 1.6 mm thick rolled sheet steel. IP 52 degree of protection. Paint shade shall be RAL 9002 for front & rear and RAL 5012 for side covers. Space heaters to be provided.			
8.02.00	Radio remote Control of EOT Crane: a) The equipment should have facility to control EOT crane by radio frequency based wireless remote unit. The equipment should be supplied with transmitter unit, receiver unit, encoder unit, decoder unit, interface panel, coupling system, battery unit and any other control gear if required.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.03.00	b) The equipment should be based upon the microprocessor based digital technology with almost nil hard wiring. c) The remote unit should communicate up to the distance of approximately 100 meters. d) The system has to integrate with the control system of crane, which operates at 110 V AC, Single phase. e) The remote unit should have transmitter which can be mounted on shoulder by suitable belt. Main controls can be of single joystick movement or double joystick movement type stepped control with spring return. The Micro control should be toggle switch type or push control type. f) Frequency allotment for radio remote unit from Govt. of India, Dept. of Telecommunication or any other agency shall be the responsibility of supplier. g) The transmitter and receiver unit should have its own frequency and address code with each system having its own security code so that one particular set becomes unique and there is no interference from any other remote unit device. A microprocessor should check all security codes. The processor should have its own watchdog circuit. The receiver FM band should be sufficiently narrow to allow only passing of desired frequency and valid command. Any error should shut down the system immediately. h) The remote unit should have safety key to prevent any unauthorized operation. All the crane operations should stop at once the communication breakdown occurs. i) On local unit (receiver side), the system should be provided with one selector switch so that EOT crane can be operated either from Operator cabin or radio remote unit. j) In case tandem operation is envisaged, a suitable selector switch shall be provided in the cabin for selection of Tandem/normal operation. k) The receiver unit along with I/O interface unit should be able to bear the vibrations and shocks encountered in normal usage of EOT crane. l) The system should have very fast response time.			
	Power Supply: (a) Incoming numbers: I. Turbine hall EOT crane: Contractor shall provide two (2) numbers 415 volts, 3 phase, 3 wire supply at operating floor near A-row column at centre of bay length with a changeover switch in enclosure. II. EOT crane for BFP: Contractor shall provide One (1) numbers 415 volts, 3 phase, 3 wire supply for each unit at BFP floor near B-row column. (b) Down shop Lead (DSL): I. DSL Shall conform to IS: 282 and shall be sized to Cater to all cranes working simultaneously with 40% cyclic duration factor for load. II. Limit voltage drop at motor terminals within 2% at extreme positions in DSL and over all voltage drop shall be maximum of 3% from the switchgear.. III. DSL shall be sized with a margin of 10% overload requirement. IV. Protective cover over DSL to be provided. V. Two (2) no. isolating switches in enclosure shall be provided at extreme ends of operating floor for disconnecting supply to DSL while maintaining the crane. DSL shall be located on 'A' -row side for Turbine Hall EOT crane. (c) Transformers Shall be of Dry type, with insulation class B or better. Following transformers shall be provided. (i) Control Transformers : 2x100%, 415V / 110V			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(ii)	Lighting Transformers	:	One 415V/240V
	(iii)	Hand lamp	:	One 415V/24V



SUB-SECTION-B – 16

BATTERY CHARGER



CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00	BATTERY CHARGER CODES AND STANDARDS		
	ANSI-C 37.90a	Guide for surge withstand capability tests	
	IS:5	Colours for ready mix paints.	
	IS : 694	PVC Insulated Cable for working voltages upto and including 1100 V.	
	IS : 1248	Specification for Direct acting indicating analogue electrical measuring instruments.	
	IS:13947 Part-1	Degree of protection provided by enclosures for low voltage switch gear and control gear.	
	IS : 13947	Specification for low voltage switch gear and control gear	
	IS : 3231	Electrical relays for power system protection.	
	IS : 3842	Application guide for Electrical relays for AC System	
	IS : 3895	Mono-crystalline semi-conductor Rectifier Cells and Stacks	
	IS : 4540	Mono crystalline semi-conductor Rectifier assemblies and equipment.	
	IS:6005	Code of practice for phosphating of Iron and Steel.	
	IS:6619	Safety Code for Semi-conductor Rectifier Equipment.	
	IS:11171/ IS:2026	Rectifier Transformer	
	IS:6875	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto 1000 V AC or 1200 V DC.	
	IS : 9000	Basic environmental testing procedures for electronic and electrical items.	
	IS:13703	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC.	
	EEUA-45D	Performance requirements for electrical Alarm Annunciation System	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.00.00		Indian Electricity Rules		
		Indian Electricity Act.		
	Technical Parameters			
	1.	Mode of Charging	Float cum Boost Charger (Automatic and Manual Mode)	
	2.	Charger Ambient Temp	50 deg C	
	3.	Voltage Rating	220V/110V	
	4.	Trickle Charging	1.4-1.42V per cell(Ni-Cd) 2.25V per cell(Lead-Acid)	
	5.	Boost Charging Mode	1.53-1.7V per cell(Ni-Cd) 2.3-2.7 V per cell(Lead-Acid)	
	6.	Automatic Voltage regulator (trickle Mode)	± 1% at 415 ± 10% and 0-100% Load, Automatic Controlled Feedback-Closed Loop	
	a.	Load Limiter current setting Range(Trickle Mode)	80%-100%	
	b.	% Stabilization of the output DC voltage	1% for ±10% input supply variation and 0-100% DC load	
	c.	Voltage Range and Stabilizing time for momentary load changes from 20%-100% and Vice versa	+/- 6 % and less than 2 secs	
	d.	Stabilizing time	Less than 15 secs	
	7.	Current setting range in Boost Charging Mode	50-100% of rated output current	
	8.	Voltage limit setting range in Boost Charging Mode	Boost charging limit	
9.	Rectifier Type	Full wave bridge Type		
10.	Ripple Content	1% Peak-Peak at 0-100% of DC Load		
11.	Rectifier Transformer	Dry and Air Cooled(AN) type Class-F Insulation with temp rise limited to Class-B at 50deg C Ambient		
12.	Charger Enclosure	IP42		
3.00.00	EQUIPMENT DESCRIPTION			
	(a.) The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC lead-acid Batteries while supplying the D.C. loads.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(b.) All Battery Chargers shall have provision to receive two input supplies along with suitable automatic changeover between the sources. Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. Trickle or Boost charging and automatic/manual mode. (c.) The chargers shall be capable of limiting the voltage or current in case DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall neither damage the Charger nor shall it cause blowing of any of the charger fuses. The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided by the Employer in the DC distribution board for remote annunciation. (d.) Digital indicating instruments with built in communication port for remote data transfer shall be provided for all chargers. Ammeters & voltmeters shall have 4-20mA analog output for current and voltage respectively. (e.) Blocking diode shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger. (f.) Digital Outputs shall be configured for connection to the DC health monitoring system for real-time charger status updation. (g.) For all Power Components (contactors, MCCBs, fuses, relays, metering instruments etc) and constructional details (sheet thickness, paint shade, gland plate thickness etc) of charger enclosure and internal wiring details, refer relevant clauses in LT switchgear specifications (as applicable). (h.) Live busbars, parts etc shall not be accessible while the charger is in energized condition. Suitable safety interlocks to be ensured.			
3.1.00	Rectifier Assembly			
	The rectifier cells shall be provided with their own heat dissipation arrangement along with forced air cooling for above 400A rating chargers and fan shall be temperature controlled with 100% standby redundancy. The rectifier shall utilize diodes/thyristors and heat sinks rated to carry 200% of the load current continuously and the temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum charger panel inside temperature.			
3.2.00	Annunciation System			
	Visual indications through indicating lamps/LEDs or annunciation fascia shall be provided in all Chargers for A.C. supply failure, Rectifier fuse failure, Surge circuit fuse failure, Filter fuse failure, Load limiter operated, Charger trip, Battery on Boost .			
	Potential free NO contacts of all above these conditions signals shall be provided for following remote alarms in the Employer's Unit Control Board:			
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CLAUSE NO.	TECHNICAL REQUIREMENTS						
2.00.00	(a)	Battery on Boost					
	(b)	Charger trouble (this being a group alarm initiated by any of the faults other than 'Battery on Boost')					
	TESTS						
	For conductance/report submission/validity of type tests, refer Sub Section-IIB, Section-VI, Part A of technical specifications.						
	2.01.01	LIST OF TYPE TESTS					
		1.	The contractor shall furnish the following type tests reports for each rating of the equipment to be supplied under this contract.				
		a)	Complete physical examination				
		b)	Temperature rise test at full load. (For chargers of up to 400A rating, Temperature rise test report for rectifier assembly at 200% of full load shall also be submitted.)				
		c)	Insulation resistance test.				
		d)	High voltage (power frequency) test on power and control circuits except low voltage electronic circuits.				
e)		Automatic voltage regulator operation test at specified A.C. supply variations at no load, half load and full load.					
f)	Load limiter operation test						
g)	Efficiency and power factor measurement.						
h)	Surge withstand capability test at the following points of the Charger: i) Across each A.C. input phase ii) Across AC input line to ground. iii) Across D.C. output terminals. iv) Across each D.C. output terminal to ground The Charger shall not exhibit any component damage and there shall be no change in performance as per (g) and (h).						
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.00.00	3.01.01	i) Environmental Tests Steady state performance tests (f) and (g) shall be carried out before and after each of the following tests. i) Soak Test ii) Degree of protection test.		
		2. Dynamic response test and Temperature rise test at full load shall be carried out on each charger before dispatch at manufacturer's works.		
		COMMISSIONING TESTS Bidder shall submit commissioning test procedure including details of all commissioning checks before commissioning the system at site.		
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SUB-SECTION-B – 17

SWITCHYARD ELECTRICAL

CLAUSE	TECHNICAL REQUIREMENTS			
CHAPTER: SWITCHYARD ELECTRICAL				
1.00.00	SCOPE AND GENERAL INFORMATION			
1.00.01	This chapter has to be read in conjunction with sub-section B-0” General electrical specification” of Technical specification Section-VI, Part-B and Sub-Section IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A. , and the intent of the specifications for various electrical equipment’s shall also cover the following scope.			
1.00.02	Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for Employer’s approval.			
1.00.03	The basic design shall include, but not limited to, the following: a) Development of general arrangement. b) Development of detailed layout (plan & section/elevation) drawings. c) Development of single line diagram with parameters of equipment and details of protection. d) Protection and control philosophy and selection of protection, control and annunciation schemes. e) Development of interlocking schemes. f) Development of switchyard structure loading details. g) Development of earthing system. h) Development of direct stroke lightning protection system. i) Insulation coordination of the EHV equipment. j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading. k) Development of clearance diagrams. l) Lighting design, Lux level calculation and conduit wiring diagram. m) Development of power & control cable laying and termination schedules. n) Relay setting calculations. o) Development of erection key diagram with bill of material. p) Foundation design and construction drawings. q) Development of cable trench layout and sections and construction drawings.			
1.00.04	Contractor shall furnish the detailed drawings for the various equipment’s covered in their scope, design calculations and construction drawings for all civil works, schematics, schedules, panel wiring diagrams, general arrangement drawings, schedules, interconnection schemes, cable schedules, interconnection schedules. etc. for employers’ approval. Contractor shall also furnish the recommended relay settings to be adopted.			
1.00.05	Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by the Owner. All equipment shall be supplied with suitable terminal connectors. The spacing for quadruple and twin moose ACSR conductor shall be 450 mm for 400kV.			
1.00.06	All equipment shall be supplied with suitable terminal connectors.. The terminal connectors shall be well coordinated with type/size of conductor and equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for horizontal or vertical take off suitable for tube/quadruple/twin/single moose conductor. For Jack Bus Line side Quad ACSR Moose and rest Twin ACSR Moose shall be used. The subconductor spacing for quadruple and twin moose ACSR conductor shall be 450 mm for			
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CLAUSE	TECHNICAL REQUIREMENTS				
1.00.07	400kV.. The terminal pads shall preferably be capable of taking the required conductor span under normal, short circuit and meteorological conditions, without effecting the performance of the equipment.				
1.00.08	The rigid busbars for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular Al. connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.				
1.00.09	The existing 400kV Switchyard is provided with 4” IPS tube as main Busbar for Bus#1, Bus #2. The equipment interconnection shall be through 4” IPS Al. tube. The existing 400kV switchyard is of one and half breaker scheme with D-type configuration as shown in the single line diagram CW-EN-9757-G-E-102(A) associated with Singareni TPP Stage-II (1X800MW).				
1.00.010	In 400kV Switchyard, for One dia (i.e. two (2) feeders & one (1) tie) two (2) Bay Marshalling Boxes (BMKs) are to be provided. The duplicated power supplies for two (2) BMKs shall be looped.				
1.00.011	All equipments shall be suitable for hot lie washing .The sag tension, conductor spacing, short circuit forces, spacer location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances. Short circuit force calculation shall be submitted by the bidder as per relevant IEC for Flexible bus and rigid bus. This short circuit force shall be considered for designing of Tower, Girder and equipment structure and their foundation.				
1.00.012	All overhead stringing shall be carried out by minimum double tension string insulator assembly. The earth wire for shielding purpose shall be double anchored at the towers/ other locations and shall run through without cutting wherever feasible so as to avoid snapping. The earth wires crossing each other shall also be bolted together for additional safety.				
1.00.013	Post insulators shall be provided at line entry and near transformers and other jumpers to avoid mechanical forces on the LA's and Bushings etc.				
1.00.014	Necessary fire wall shall be provided between single phases of reactors. The fire wall height shall be 500mm above reactor bushing.				
1.00.015	The pit size of reactors shall be designed for minimum 1000mm beyond the physical dimension of the reactor.				
1.00.016	The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin moose and 1.5T/conductor in case of quad moose conductor. 0.8T/conductor in case of ground wire. The foundations and structures etc. shall be designed accordingly.				
	The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All Gantries and towers (Including intermediate/ required for turning etc.) as required from GT, ST stringing , earth wire & its anchoring on A-Row column of TG Building with in plant boundary are to be provided by the contractor. Minimum height of 400KV gantry for AIS shall be 16M+8.5MPeak however intermediate gantry height for O/H connection for GT shall be min. 22m+8.5m. Minimum height of 400KV AIS equipment level shall be 8.0M from the plinth level. The gantry width for 400kV AIS shall be min. 27mt or as required to meet the specified clearances.				
	Various minimum heights of the 400KV AIS switchyard shall be as given below from plinth level:				
	Voltage Level	Equipmt.1 st level	2 nd level	3 rd level	
	400KV (1½ breaker scheme.)	8000mm	16000mm	23000mm	
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CLAUSE	TECHNICAL REQUIREMENTS			
	The peak of towers for 400kV shall be 8500mm. The Bay width (Beam Span) for 400kV gantry structures should be 27mt . All 'T'off connection associated with lines/transformers shall be provided with a bye pass utilizing two PG clamps for each 'T'off. As far as possible, the conductor shall pass without cut/joint unless otherwise necessary for planned shut-down/maintenance. 1.01.15 The switchyard shall be provided with peripheral roads and roads for maintenance/approach for major AIS equipment for maintenance purpose. 1.01.16 CVT JB shall have fuses for each core of the CVT. 1.01.17 The illumination level for AIS shall be 20 lux in general and minimum 50lux on equip-ment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on Lightning Masts/ High lighting masts only. Specification of lighting is provided elsewhere in the specification. 1.01.18 Contractor shall provide panel mounted automatic start / stop type centrifugal self-priming pump for sump pit to drain the water in approximately one (1) hour . The contractor shall also provide suitable pedestal/ foundation for this pump. The pump shall be complete with all necessary fittings such as NRV, inlet & outlet pipes of suitable length and dia. 1.01.19 As far as possible the conductor shall pass without cut/joint unless otherwise necessary for planned shutdown/maintenance. 1.01.20 Entire area of Switchyard of Present scope shall be provided with broken stone filling which shall consist of two layers.. The first layer shall be 75mm thick base course of 20mm of nor-mal size and a final layer of minimum 75mm thickness of stone aggregate of 40mm nominal size shall be spread uniformly. In Switchyard before laying o fbase course , the subgrade shall be properly compacted, and the top layer of the soil shall be treated for anti-weed con-sidering the type of weeds found in the vicinity. In existing 400kV switchyard , removal of gravel in present scope of bays / new bays for equipment foundations and re laying with new gravel is in the scope of bidder. 1.01.21 The control & protection panels , MCC / ACDB, DCDB etc shall be located suitably in the switchyard control room building . Adequate AC & Ventilation in Control room building and Ventilation of switchgear room / MCC room etc. is to be provided by the contractor for the buildings in the Bidder scope . Specification of AC & Ventilation is specified elsewhere in the specification (Part-B Mechanical). 1.01.22 The cable trenches from control room to switchyard shall be designed to cater as required for bays indicated in SLD. The contractor shall construct the common sections suitably of ap-propriate sizes upto common points so that the same can be extended in future. 1.01.23 Voltage drop for sizing of power cables shall not be more than 6%. 1.01.24 one no(1no) suitable industrial socket and suitable power cable for oil filtration equipment for Bus reactor shall be provided.			
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CLAUSE	TECHNICAL REQUIREMENTS			
1.01.25	The cable trenches , cable trays & supports, accessories , Roads , drains, fencing with gate required for present scope of bays and its interconnection to existing cable trenches , drains , storm water drain and fencing etc .			
1.01.26	Removal of gravel in present scope of bays for equipment foundation / erection and its re laying with new gravel is also in the scope of bidder if applicable. Civil work related to SCCL scope Line bays only is not in Bidders scope, Like any dismantling, re-gravel, Trench, equipment foundation etc.			
1.01.27	Dismantling of existing fencing, Roads , Foundations, Re-routing of Pipe lines above the ground & below the ground available in the present scope of Bays is also in the scope of Bidder.			
1.01.28	Supply & laying of power, control cables , Screen cable, Fibre optic cable and cabling between Contractor supplied equipment and Owner supplied equipment required. etc , from owner feeders , panels and from present scope of panels to existing panels to complete the system is in the scope of Bidder.			
1.01.29	Lighting, earthing , lightning protection of Present scope of bays .			
	However any items though not specifically mentioned but which are required to make the switchyard complete in all respects for its safe, efficient, reliable and trouble free operation shall be supplied and erected by the Contractor, unless they are specifically excluded in the text of exclusions given in the specification.			
1.02.00	CLEARANCES : The minimum clearances for 400kV AIS shall be as given below:			
				400kV
			Phase to earth clearance	3500mm
			Phase to Phase clearance	4000mm
			Sectional clearance	6500mm
	The Contractor shall supply the structures suitable to meet the above clearances. The Contractor shall furnish clearance diagram in support of same for approval of Owner.			
1.03.00	EARTHING : For earthing 50x6 mm GS flat shall be used in all cabinets, MOM boxes, panels and balance all other earthing such as all equipments, towers, cable trenches etc shall be through 75x12mm GS Flat. The Switchyard earthing criteria is given in Annexure-II of this specification.			
1.04.00	LIGHTING :The illumination level shall be minimum 20 lux in general and 50 lux on equipment boxes, at equipments of switchyard . Detailed specification covered in Section -VI, Part-B, B-11(Lighting)			
1.05.00	EQUIPMENT CONNECTOR RATING :The connectors and clamps shall be rated same as the connected equipments.			
1.06.00	CIVIL DESIGN :The civil design criteria is given in Civil Chapter of Technical specification .			
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1.07.00 CONTROL PHILOSOPHY :The switchyard control philosophy and protection system is described in chapter B13 Substation Automation System of section-VI Part-B.

1.08.00 **SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED:**
The system shall be designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.

1.09.00 **SITE SUPERVISION OF EQUIPMENTS**
The contractor shall ensure that, erection, testing and commissioning of, GIS, Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & protective relays is carried out, under the supervision of manufacturer of respective equipment.

1.10.00 **Insulation Co-Ordination and Selection of Surge Arrestor**
1.10.01 The contractor shall be fully responsible for complete insulation co-ordination of switchyard. Contractor shall ensure that adequate protective margin is available. If surge arrestors at some more locations other than those indicated in the tender drawings are required to be provided, the same shall be deemed to be included in the offer.

1.11.00 **General Parameters :**
1.11.01 **AIS 400kV Switchyard :**

Sl.no	Description	400KV system
a	i)Highest System voltage	420kV rms
	ii)Rated / Nominal system voltage	400kV rms
b)	Lightning impulse voltage (ph to earth& between phases)	±1425kVp
	Across isolating distance	1425(+240) KVp
c)	Switching impulse voltage (ph to earth)	±1050kVp
	Across isolating distance	900(+345) KVp
d	Power frequency withstand (for 1 min. rms.) to earth & between phases	520 & 610kVrms as per IEC
e	Max.fault level(1sec)	50kA kA
e.1	Short circuit breaking current Asymmetrical	61.2kA
d	Rated dynamic with stand current	125kAp
f	PD Level	<5pico coulomb
g	Rated frequency	50Hz
h	Rated Ambient Temperature	50.deg.Cen
i	System earthing	Effectively earthed
j	Min.creepage (25mm/kV)	10500mm
k	Seismic acceleration	0.3g
l	Max. radio interference for freq. between 0.5 MHz and 2.0 MHz at 266 kV rms	1000micro volt
m	Corona extinction voltage	Not less 320kV rms

Note: Bidder to consider above parameters for all the equipments of AIS. For other

CLAUSE	TECHNICAL REQUIREMENTS			
1.12.00 1.12.01 a) b) c) 1.12.02 a) b) c)	Parameters bidder to refer respective chapter. TYPE TEST REQUIREMENTS TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN 400KV AIS CIRCUIT BREAKER : All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. The validity period of reports shall be as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical Equipment in power Transmission-May2020 & with latest amendments for the from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. However if contractor is not able to submit report of the type test(s) conducted as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. TYPE TEST REQUIREMENTS FOR 400KV AIS CIRCUIT BREAKER: The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of bids. The type test charges shall be paid as per the charges quoted for each of these type tests separately in the relevant schedule of BPS (Bid Proposal Sheet) & no qty variation is allowed. only for the test(s) conducted successfully under the contract and upon certification by the Employer's engineer. The type tests shall be carried out in the presence of the Employer's representative, for which minimum 60 days' notice shall be given by the Contractor. The Contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set up, instrument to be used, procedure, acceptance norms, recording of various parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out In case the Contractor has conducted such specified type test(s) according to the relevant standard and / or specification as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments as on date of bid opening, submit the type test reports to the Employer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should			
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have been witnessed by a Client. The Employer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the Contractor.

1.12.03

Type tests to be conducted on 400KV AIS Circuit Breaker

a) Dielectric tests	b) Radio interference voltage test
c) Temperature rise test	d) Short time withstand current, peak with stand test, short circuit test duties, short line fault test
e) Mechanical endurance	f) Out of phase making & breaking test
g) Line charging current breaking test	h) Coronal test for 400kV
i) IP: 55 test on each type of box	j) Seismic with stand test with structure for 400kV
k) Test for reactor switching duty for 400kV CB (for Bus reactor)	

1.13.00

CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST (for 400kV AIS only):

The corona and RIV tests shall confirm to the requirements as per **Annexure- A** to this chapter. The seismic withstand test shall conform to requirements as per **Annexure -B** to this section.

Annexure – A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST (For 400 kV AIS only)

1.0

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 measurement of radio interference voltage (RIV).

2.0

Test Methods for RIV:

2.1

RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. 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 result shall be in microvolts. Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein. In measurement 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.

2.2

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% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

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3.0	Test Methods for visible Corona : The purpose of this test is to determine the corona extinction voltage of the 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 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test 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 the visible corona (negative or positive polarity) disappears.			
	Annexure – B SEISMIC WITHSTAND TEST (for 400 kV AIS only)			
a.)	The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.			
b.)	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 at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.			
2.00.00	CIRCUIT BREAKER:			
2.01.00	GENERAL			
2.01.01	Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.			
2.02.00	DUTY REQUIREMENTS:			
2.02.01	Circuit breaker shall meet the requirements of Capacitive class : C2, Mechanical Endurance class:M2, Electrical Endurance class:E2 type of duty as per IEC for 400kV and under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 400kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily			
2.02.02	The circuit breaker shall be capable for breaking the steady & transient magnetizing current corresponding to 400kV transformers up to 630 MVA rating. It shall also be capable of breaking line charging currents as per IEC 62271-100 with a voltage factor of 1.4			
2.02.03	The rated transient recovery voltage for terminal fault and short line faults shall be as per IEC:62271-100.			
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2.02.04 2.02.05 2.02.06 2.02.07 2.02.08 2.03.00 2.03.01 2.03.02 2.04.00 2.04.01	The circuit breakers shall be reasonably quiet in operation. Noise level in excess of 140 dB measured at base of the breaker would be unacceptable. Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker. The Bidder may 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, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time While furnishing particulars regarding the D.C. component of the circuit breaker, the Bidder shall note that IEC-62271-100 requires that this value should correspond to the guaranteed minimum opening time under any condition of operation The critical current which gives the longest arc duration at lock out pressure of extinguishing medium and the duration shall be indicated. All the duty requirements specified above shall be provided with the support of adequate test reports to be furnished.. CONSTRUCTIONAL FEATURES. All making and breaking contacts shall be sealed and free from atmospheric effect. In the event of leakage of extinguishing medium to a value, which cannot withstand the dielectric stresses specified in the open position, the contacts shall preferably self close. Main contacts shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts, then the main contacts shall be easily accessible for inspection and replacement. Main contacts shall have ample area and contact pressure for carrying the rated current under all conditions. The interrupter sectional drawing showing the following conditions shall be furnished: a) Close position b) Arc initiation position c) Full arcing position d) Arc extinction position e) Open position. All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker. SULPHUR HEXAFLORIDE (SF6) GAS CIRCUIT BREAKER Circuit breakers shall be single pressure type. Design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on insulated surfaces of the circuit breaker			
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2.04.02	In the interrupter assembly, there shall be absorbing product box to eliminate SF6 decomposition products and moisture. The details and operating experience with such filters shall be brought out in additional information schedule.			
2.04.03	Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes			
2.04.04	Material used in the construction of circuit breakers shall be such as fully compatible with SF6			
2.04.05	The SF6 gas density monitor shall be adequately temperature compensated to model the density changes due to variations in ambient temperature within the body of circuit breaker as a whole. It shall be possible to dismantle the monitor without removal of gas.			
2.04.06	Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.			
2.05.00	OPERATING MECHANISM:			
2.05.01	Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.			
2.05.02	The operating mechanism shall be anti-pumping and trip free (as per IEC definition) electrically and either mechanically or pneumatically under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and/or gas			
2.05.03	The operating 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 operated closing devices. A mechanical indicator shall be provided to show open and close positions of breaker. It shall be located in a position where it will be visible to a man standing on the ground with the mechanism housing door closed. An operation counter shall also be provided			
2.05.04	Closing coil shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coils 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. If additional elements are introduced in the trip coil circuit their successful operation for similar applications of outdoor breaker shall be clearly brought out in the bid.			
2.05.05	Working parts of the mechanism shall be of corrosion resisting material. Bearings requiring 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			
2.05.06	Operating mechanism shall normally be operated by remote electrical control. Electrical			
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	tripping shall be performed by shunt trip coil. Provision shall also be made for local electrical control. 'Local / remote' selector switch and close & trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided. 2.05.07 Operating mechanism and all accessories shall be in local control cabinet. A central control cabinet for the three poles of the breaker shall be provided along with supply of necessary tubing, cables, etc. 2.05.08 Provisions shall be made on breakers for attaching an operation analyser to perform speed tests after installation at site to record contact travel against time and measure opening time. 2.05.09 The Bidder shall furnish curve supported by test data indicating the opening time under close-open operation with combined variation of trip coil and operating media along with the bid. 2.06.00 PNEUMATICALLY OPERATED MECHANISM 2.06.01 Bidder shall offer unit compressor with each circuit breaker. The unit compressor are to be located outdoor near the breaker(s). 2.06.02 The breaker local air receivers shall comply with the requirement specified, and shall have sufficient capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling. 2.06.03 Independently adjustable pressure switches with potential free ungrounded contacts to actuate lockout device shall be provided. This lock out device with provision for remote alarm indication shall be incorporated in the circuit breaker to prevent operation whenever the pressure of the operating medium is below that required for satisfactory operation at the specified rating. The scheme should permit operation of all block and alarm relays as soon as the pressure transient present during the rapid pressure drop has been damped and a reliable pressure measurement can be made. Such facilities shall be provided for following conditions: a) Trip lockout pressure - 2 nos. b) Close lockout pressure - 1 no. c) Extreme low pressure - 1 no. d) Auto reclose lock out pressure - 1 no. 2.06.04 The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with the air pressure immediately before operation between 85% and 110% of the rated supply pressures. The make/break time at this supply pressure shall not exceed the specified make/ break time within any value of trip coil supply voltage as specified. 2.07.00 SPRING OPERATED MECHANISM 2.07.01 Spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. Opening spring shall be supplied with limit switch for automatic charging and other necessary accessories.			
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2.07.02 2.07.03 2.07.04 2.07.05 2.07.06 2.07.07	As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Breaker operation shall be independent of the motor, which shall be used solely for compressing the closing spring. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring. Closing action of the circuit breaker shall compress the opening spring ready for tripping. When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet. 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.			
2.08.00	HYDRAULICALLY OPERATED MECHANISM			
2.08.01 2.08.02 2.08.03 2.08.04 2.08.05 2.08.06 2.08.07	Hydraulically operated mechanism shall comprise operating unit with power cylinder, valves, and low pressure reservoir, motor, etc The hydraulic oil used shall be fully compatible for the specified temperature range. The oil pressure controlling the oil pump and pressure in the high pressure reservoir shall have adequate number of spare contacts for continuous monitoring of low pressure, high pressure, etc., in control room. The necessary remote equipment shall also be provided. The mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto reclose duty The hydraulically operated mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up. The operating time at the lowest pressure for a particular operation shall not exceed the guaranteed operating time within any value of trip coil-supply voltage as specified. Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for loss of nitrogen shall be provided and wired suitably upto the central control cabinet. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.			
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2.09.00	FITTINGS AND ACCESSORIES			
2.09.01	Following is partial list of some of the major fittings and accessories to be furnished as integral part of the breakers. Number and exact location of these parts shall be indicated in the drawing.			
2.09.02	Control unit / Central control cabinet complete and provided with the following: Double compression type cable glands, lugs, ferrules, etc. b) Local/remote changeover switch c) Operation counter d) Fuses, as required e) Anti-pumping relay/contactors f) Rating and diagram plate in accordance with IEC including year of manufacture, etc. g) Gauges for SF6 gas pressure, pneumatic/hydraulic pressure. h) Gas density monitor with alarm and lockout contacts.			
2.09.03	Hollow insulator columns a) The insulators shall conform to requirements stipulated elsewhere in the specification . All routine tests shall be conducted on the insulators as per relevant IEC. In addition the following routine tests shall also be conducted on hollow column insulators. a) Ultrasonic test b) Pressure test c) Bending load test in 4 directions at 50% specified bending load. D)Bending load test in 4 directions at 100% specified Bending load as a sample test. The tested insulator will not be used in CB. e) Burst pressure test as a sample test			
2.09.04	SUPPORT STRUCTURES The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or support insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. The height of center line of conductor shall be as given elsewhere in the specification.			
2.09.05	Terminal connectors shall conform to requirements stipulated elsewhere in the specification			
2.10.00	ADDITIONAL FITTINGS FOR PNEUMATIC CIRCUIT BREAKER a) Unit compressed air system. b) Breaker local air receivers c) Pressure gauge, spring-loaded safety valve and pressure switch with adjustable contacts d) Pressure switch to initiate an alarm if the pressure in the auxiliary reservoir falls below a preset level for longer than it is normally necessary to refill the reservoir. e) Stop, non-return and other control valves, piping and all accessories upto breaker mechanism housing.			
2.10.01	UNIT COMPRESSED AIR SYSTEM The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves(if any), isolating valves, drain ports, etc.			
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2.10.02	Air Compressor: a) The air compressor shall be driven by automatically controlled motor. It shall be of air cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. b) The compressor size shall be such that it is capable of performing following operations satisfactorily : i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations ii) Air charging time not exceeding 20 minutes after one CO operation of the breaker c) The compressor shall be provided with automatic adjustable unloading device, if necessary, during starting. Each compressor shall be equipped with a time totalizer d) The compressors and its accessories shall conform to the type tests and shall be subject to routine tests as per applicable standards.			
2.10.03	Intercooler and After cooler : Intercooler between compressor stage and after cooler at discharge of H.P. cylinder shall be included in Contractor's scope. They shall be of air cooled type and shall be designed as per ASME Code of IEMA Standards. The design pressure on the air side of cooler shall be 1.25 times the working pressure. A corrosion allowance of 3mm shall be included for all steel parts			
2.10.04	Air Receivers a) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker b) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized c) Accessories such as suitable sized safety valve to relieve full compressor discharge at a set pressure equal to 1.1 times the maximum operating pressure, dial type pressure gauge with isolating and drain valve and test connection shall be provided. d) Quality of Air : Compressed air used shall be dry and free of dust particles. Arrangement for conditioning the compressed air shall be provided as an integral part of air compressor system. The quality of air shall be compatible with the parts used in the system. All necessary components required to make it compatible shall be included.			
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2.12.00

CIRCUIT BREAKER PARAMETERS:

Sl.no	Description	
a)	Type of Circuit breaker	Out door SF6 insulated, Single pressure, Live Tank Type, 50Hz
b)	No. of poles	Three(3poles)
c)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO
d)	Total closing time	Not > than 150ms
e)	Reclosing	1ph & 3ph high speed auto reclosing as required .
f)	Trip and closing coil voltage	220V DC
g)	Auxiliary contacts	As required plus10NO & 10NC contacts per breaker as spare.
h)	Noise level	Maximum 140dB at 50m distance from base of circuit breaker
i)	Rated terminal load	Adequate to withstand 100kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity
k)	Temperature rise over	As per IEC:62271-100
l)	Type of operating mechanism	Pneumatic/spring/hydraulic/or a combination of these
m)	Minimum creepage distance	25mm/Kv
n)	Support structure height	Adequate so that lowest part of support insulator of equipment is minimum 2550mm from plinth level.

2.12.01

400kV Class Circuit Breakers (AIS)

Sl.no	Description	
a)	Rated continuous current	Minimum: 3150A/2000A at rated ambient temperature current capacity as per the SLD.
b)	Rated out-of-phase breaking	12.5kA rms
c)	Rated line charging breaking current (voltage factor of 1.4)	600A at 90deg.cen leading power factor with maximum permissible switching overvoltage of 2.3 pu
d)	Rated small inductive current Breaking capacity	Corresponding to interrupting steady and transient magnetising current of 50 to 630 MVA transformers with overvoltage less than 2.3 pu
e)	First pole to clear factor	1.3
f)	Rated break time	As per IEC
g)	Phase to phase spacing	7000mm
h)	Controlled switching Device (CSD)	The controlled switching requirements of Circuit Breaker as per the SLD. The details of CSD are given at Annexure-I

CLAUSE	TECHNICAL REQUIREMENTS		
2.13.00	Mandatory Maintenance Equipments : 1. SF6 Gas Handling Plants:- a) SF6 gas filling and evacuating equipment(Portable), - Not Required b) SF6 gas filtering, drying, storage and recycling plant, - Not Required 2. SF6 Gas leak detector- Not Required. 3.Operational Analyzer (along with DCRM Kit) , Qty:1no : The operational analyser shall meet the following requirements: a) Operational analyser shall be one complete system, which once installed should record all the parameters, as laid down in subsequent clauses. b)It shall have facility to record the breaker contact movement during opening, closing, au- to reclosing and make-break operation, the speed of contacts at various stages of opera- tion, travel of contacts, opening time, closing time and make break time etc. The analyser shall have provisions for recording at least 12 different functions of the circuit breaker. All necessary transducers (i.e., three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient for recordings at site on a completely as- sembled and erected breaker. c)All the necessary catalogues write up for operation and maintenance of the analyser shall be furnished along with each analyser and peripheral system. The necessary equipments for monitoring various parameters of circuit breaker termed as signature analysing shall be supplied along with all software, laptop computer, devices etc. with the breaker. The same shall be demonstrated at site on a fully assembled breaker. 4.Self-powered hydraulic aerial working platform with articulated and fly boom for General purpose maintenance in switchyard and Transformer yard. (Suitable for 24m working height)- Qty : 1no . All above maintenance equipments shall be demonstrated at site during handover. ANNEXURE-I Requirement of Controlled Switching Device for 400KV Circuit Breaker The circuit breaker with controlled switching as indicated in single line diagram shall meet the following requirement: 1. The Switching controlled Device shall be used to reduce increased over voltages, re igni- tion between circuit breaker contacts that may be caused by normal switching of high volt- age circuit breakers and hence optimize the stresses on circuit breaker while switching the circuit. The switching-controlled device will be called device henceforth.		
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CLAUSE	TECHNICAL REQUIREMENTS			
2. 3. 4. 5. 6. 7. 8. 9. 3.00.00 3.01.01	Circuit breaker should be able to be switched while switching controlled device is not in operation e.g., during maintenance work or power supply is not connected, a bypass shall be provided to the device. In these cases, the switching commands will then be forwarded directly to the circuit breaker via this Bypass. The switching time will not be controlled with these switching operations. The controller shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate. The device should have display facility at the front for the settings and measured values, alternatively a laptop shall be supplied with each CSD to facilitate display at the front for the setting and measured values. The device shall have self-monitoring facility. During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. The control switching device provided shall be networked to an Engineering workstation (EWS) located in the switchyard control room. It shall be possible to extract the switching oscillographic records and to do CSD parameterization from this EWS. All necessary software & hardware shall be in bidder's scope. It shall have self-monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm. The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification. The device shall have time setting resolution of 0.1 ms or better. Test reports for the following type tests shall be submitted: - Dielectric withstand test as per IEC 60255-27. - High voltage Impulse test as per IEC 60255-27. - Slow damped oscillatory wave test as per IEC 60255-26 - Fast transient test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-4) - Electrostatic Discharge test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-2) - Surge Immunity test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-5) - Power frequency magnetic field test as per IEC 60255-26 (class 5 installation as per base standard IEC 61000-4-8) - Radiated radio frequency electromagnetic field test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-3) - Conducted disturbance induced by radio frequency field as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-6) - Power frequency immunity test on binary input as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-16) DISCONNECTOR : GENERAL The isolators and accessories shall conform in general to relevant IEC 62271-102 (or equivalent Indian Standard) except to the extent explicitly modified in specification. Earth switches shall be provided on isolators as marked on SLD. Isolators shall be horizontal centre break type.			
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CLAUSE	TECHNICAL REQUIREMENTS			
3.01.02 3.02.00 3.02.01 3.02.02 3.02.03 3.02.04 3.03.00 3.03.01 3.03.02	The isolators and earth switches shall be A. C / D.C. motor operated. DUTY REQUIREMENTS Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. Mechanical Endurance : M2 type of duty as per IEC for 400kV and earthing switches shall be of class M0 / M1 duty. 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 failsafe 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 relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for 'DC' control scheme of the isolator as well as for AC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised. The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity. The isolator shall be capable for making / breaking normal currents when no significant change in voltage occurs across the terminals of each pole of the isolator on account of making / breaking operation. CONSTRUCTIONAL FEATURES : The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surfaces shall be silver plated. The thickness of silverplating should not be less than 25 microns. The contacts shall be accurately machined and self aligned. The isolator shall be provided with a galvanized steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self-supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level.			
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CLAUSE	TECHNICAL REQUIREMENTS			
3.03.03 3.03.04 3.03.05 3.04.00 3.05.00 3.05.01 3.05.02	All metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities, if provided on current carrying parts, shall be made of copper silicon alloy or equivalent. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces. The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. The insulator of the isolator shall conform to the requirements stipulated under clause no: 06.00.00 as specified in the specification and shall have a min. cantilever strength of 800 kg for 400kV. Pressure due to the contact shall not be transferred to the insulators after the main blades full close. The insulators shall be so arranged that leakage current will pass to earth and not between terminals of the same pole or between phases. The terminal connectors shall conform to requirements stipulated under clause no:08.00.00 as specified else where in the specification. EARTHING SWITCHES: Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructional interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa. OPERATING MECHANISM AND CONTROL The Contractor shall offer, motor operated switches having padlock arrangement on both 'ON' and 'OFF' positions. Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches. It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed. Control cabinet/operating mech. box shall conform to requirements stipulated in clause no: 08.00.00 else where in the specification and IS:5039/IS 8623/IEC 439 as applicable OPERATION Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked. 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.			
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3.05.03 The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch

3.06.00 TESTS

3.07.01 In continuation to the requirements stipulated under Part-I the isolator alongwith operating mechanism shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC 62271-102. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator assembled completely with all accessories as acceptance test. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close. Acceptance test shall be carried out with operating box

3.06.02 The insulator shall conform to all the type tests as per IEC60168. In addition to all type, routine and acceptance tests, as per IEC-60168, the following additional routine/ acceptance tests shall also be carried out:

- a) Bending load test in four directions at 50% min. bending load guaranteed in all insulators.
- b) Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot. c) Torsional test on sample insulator of a lot.

3.7.00 General PARAMETERS:

	Description	Parameter
a)	Type of isolator	Out door type , 50Hz
b)	No. of poles	Three(3poles)
c)	Rated operating time	Not > than 12sec
d)	Control voltage	220VDC
e)	Auxiliary contacts on isolator	Min.8NO & 8NC contacts per pole/isolator .
f)	Auxiliary contacts on earth/ safety/grounding/high speed switch	Min.6NO & 6NC contacts per pole/isolator .
g)	Operating mechanism of isolator and earth switch	AC/DC/universal motor
h)	Minimum creepage distance	25mm/Kv
i)	Rated ambient temperature	50 degree Celsius
j)	Support structure height	Adequate so that lowest part of support insulator of equipment is minimum 2550 mm from plinth level
k)	Temperature rise	As per Table III of IEC 60694 for an ambient of 50 deg. C

3.07.01 400KV Isolator :



	Description	Parameter
a)	Rated continuous current	Minimum 3150/2000 A at rated ambient temperature as per the Single line diagram
b)	Rated short time withstand current of isolator and earthswitch	50 kA rms for One (1) second
c)	Rated Insulation levels	
d)	Rated one minute power. Frequency withstand voltage	i) 520 kV rms between live terminals and earth ii) 610 kV rms across isolating distance
e)	Rated lightning impulse Withstand voltage	i) ± 1425 kVp between live terminals and earth. ii) ± 1425 kVp impulse on one terminal and 240 kVp power freq. Voltage of opposite polarity on other terminal (across isolating distance).
f)	Rated switching impulse Withstand voltage	i) ± 1050 kVp between live terminals and earth. ii) ± 900 kVp impulse on one terminal and 345 kVp power freq.voltage of opposite polarity on other terminal (across isolating distance).
g)	Phase to phase spacing	7000mm

4.00.00

INSTRUMENT TRANSFORMER : CODES AND STANDARDS

Current transformers IEC 61869-1&2, IS: 2705, IS:16227
Voltage transformers IEC 61869-1&5, IEC 60358, IS: 3156
Insulating oil IS: 335, IEC:60296

4.01.00

GENERAL REQUIREMENTS (For AIS)

4.01.01

The instrument Transformers i.e Current and voltage transformers / CVT shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units. All exposed mild steel shall be hot dip galvanised or painted with Grey color of shade RAL 9002.The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals

CLAUSE	TECHNICAL REQUIREMENTS		
	 at the associated terminal block. For Current transformers , no oil shall come in contact with zinc galvanized surface. 4.02.0 The Instrument transformer shall be with Polymer Insulator. For Current transformer shall have cantilever strength of not less than 500kg for 400kV. For 400kV CVT cantilever strength shall not be less than 250kg. 4.03.00 Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block . 4.04.00 CURRENT TRANSFORMERS (CTs) 4.04.01 The CTs shall have single primary of either ring type or hair pin type or bar type. Wound primary is not acceptable. 4.04.02 In case of "Bar Primary" inverted type CTs, the following requirements shall be met: a) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution. b) The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses. c) The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome. 4.04.03 The insulator shall be one piece without any metallic flange joint. The CT shall be provided with oil sight glass. 4.04.04 The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters. 4.04.05 Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted. 4.04.06 The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. 4.04.07 The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box. 4.04.08 The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below. 4.04.09 The CTs shall be suitable for high speed auto-reclosing		
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4.04.10 4.04.11 4.04.12 4.04.13 4.05.00 4.05.01 4.05.02 04.05.03 04.05.04 04.05.05 04.05.06	The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT. The CTs shall be suitable for horizontal transportation The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT. Contractor shall supply 2nos. oil sampling device for every 20nos. Minimum 2nos. oil sampling device for each substation. The CT shall have provision for measurement of capacitance and tan delta as erected at site <u>VOLTAGE TRANSFORMERS (CVTs) (AIS):</u> Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit. The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens. The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground. The secondaries shall be protected by HRC cartridge type fuses for all windings. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.. The damping device shall be permanently connected to one of the secondary winding and shall be capable of suppressing ferro-resonance oscillations. CVTs shall be suitable for high frequency (HF) coupling for power line carrier communication. Carrier signals must be prevented from flowing into potential transformer (EMU) metering circuit by means of RF choke/reactor suitable for effective blocking the carrier signals over the entire frequency range of 40 to 500 kHz. HF terminal shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment. The HF terminal shall be provided with earthing link with fastener. A protective surge arrester/spark gap shall preferably be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor, tuning reactor, RF choke, etc. due to short circuit in transformer secondary. The details of this arrangement (or alternative arrangement) shall be furnished by Contractor for Employer's review. The accuracy of metering core shall be maintained through the entire burden range upto 75VA on all three windings without any adjustments during operations. The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs			
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04.06.00

MARSHALLING BOX : Marshaling box shall conform to all requirements as given in clause no:08.00.00. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals .

04.07.00

GENERAL PARAMETERS FOR CURRENT TRANSFORMERS:

Sl.no	Description	Parameter
a)	One minute power frequency withstand voltage between secondary terminal and earth	5kV
b)	Partial discharge level	10 pico Coulombs max.
c)	Temperature rise	As per IEC
d)	Type of insulation	Class A
e)	Number of cores	Five (5): Details are given in table-1 below
f)	Rated frequency	50 Hz
g)	System neutral earthing	Effectively earthed
h)	Installation	Outdoor (up right)
i)	Seismic acceleration	0.3 g horizontal
j)	Number of terminals in marshalling box.	All terminals of control circuits wired up to box marshalling box plus 20 terminals spare.

04.07.01

400 kV Current Transformers (oil filled type)

Sl.no	Description	Parameter
a)	Rated Short time thermal current	50kA for 1sec
b)	Rated Dynamic current	125kA(peak)
c)	Rated Extended Primary current	120% of rated primary current as per SLD

04.08.00

PARAMETERS FOR VOLTAGE TRANSFORMERS (For AIS): General Parameters

Sl.no	Description	
a)	Standard reference range of frequencies	96% to 102% for protection. 99% to 101% for measurement
b)	High frequency .capacitance	With in 80% to 150%
c)	Equivalent resistance over entire carrier frequency range	<40 ohms
d)	One min.power frequency with stand voltage (B/W LV(HF) terminal	10KV rms & earth for exposed terminals or 4kV rms for terminals



04.09.00

TESTS

a) The current and voltage transformers (For AIS) shall confirm to type tests and subjected to routine tests in accordance with the relevant IEC/IS and shall also conform to the following additional type tests as applicable:

- i) Radio Interference and Corona test
- ii) Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic circuit (For CT Only)
- iii) Seismic withstand test along with structure (for 400kV only)
- iv) Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only)
- v) Multiple chopped impulse test on Primary winding.

vi) In addition to routine tests as per IEC/IS, measurement of partial discharge in continuation with power frequency withstand test required for 400 kV current transformer. ISF (Instrument Security Factor) test will be done as part of Routine acceptance test.

TABLE-I

		enclosed in weather proof box .
e)	No of terminals in cabinet mFor secondary winding	Required , plus 10nos spare.
f	Rated thermal burden	750VA.
g)	Partial discharge	Max.10 pico coulombs
h)	Rated voltage factor	1.2continuous, 1.5 for 30sec
i)	No of cores	As per details given I Table-II below
j	CVT HF capacitance	4400/8800pf (as required) for 400kV system.



CORE DETAILS OF 400kV CTs

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 2000A.

CT No./ Core No.	Current (A)	Ratio	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	Application
1	2000	1000/1	-----	PS	2000/1000	10/5 Ohm	30/ 60	Bus Differential check
2	2000	1000/1		PS	2000/1000	10/5 Ohm	30/ 60	Bus Differential main
3	2000	1000/500/1	20/20/20	0.2S				Metering and synch.
4	2000	1000/500/1		PS	4000/2000/1000	10/5 /2.5Ohm	30/ 60/120	Transformer Back up / line protection
5	2000	1000/500/1		PS	4000/2000/1000	10/5 /2.5Ohm	30/ 60/120	Trans Diff./ Line protection

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV CVT Primary Voltage : 400/ $\sqrt{3}$ for Primary I,II,III

TABLE – II

Secondary Core	Applica-tion	Rated Voltage (V)	Secondary Accuracy	Output Burden – Minimum
I	Protection	110/ $\sqrt{3}$	3P	75 VA
II	Protection	110/ $\sqrt{3}$	3P	75 VA
III	Metering	110/ $\sqrt{3}$	0.2	75 VA

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 75 VA on all the three windings without any adjustments during operation.

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

05.00.00

SURGE ARRESTOR

05.01.00

GENERAL : The surge arrestors shall conform in general to IEC-60099-4 and IS:3070 -part3 / IS:15086(part-4) except to the extent modified in the specification.

CLAUSE	TECHNICAL REQUIREMENTS			
05.01.01 05.02.00 05.02.01 05.03.00 05.03.01 05.03.02 05.03.03 05.04.00 05.04.01 05.04.02	Arrestors shall be hermetically sealed single phase units, self-supporting construction, suitable for mounting on lattice/tubular type support structures. DUTY REQUIREMENTS The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines. The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions. CONSTRUCTIONAL FEATURES (FOR AIS) The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties. SAs shall have pressure relief devices suitable for preventing violent failure of insulator housing and providing path for flow of rated fault currents in the event of arrester failure. Outer insulator of Surge arrestor shall be of Polymer type. The SA shall not fail due to polymer contamination. Polymer housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to maximum design value for SA. The cantilever strength of the surge arrestor shall be minimum 500kg for 400kV and above voltage class system. The end fittings shall be made of corrosion proof material and preferably be non-magnetic. The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with O-rings/elliptical cross section gasket of Neoprene or Butyl rubber. FITTINGS AND ACCESSORIES FOR AIS Each SA shall be complete with insulating base for mounting on structure. SAs shall be provided with grading and/or corona rings as required. i) Self-contained discharge counters, suitably enclosed for outdoor use (with Min.IP:56 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA along with necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milliammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up. ii) The surge counter shall be provided with a potential free contact which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to substation Automation system. iii) Insulated copper conductor of adequate size and length shall be used for connecting discharge counter terminal and lightning arrester earth terminal. Insulation level of the conductor shall not be less than 5 kV. Suitably sized bypass copper shunts shall be provided for bypassing the discharge counter for removal / maintenance of the counter.			
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iv) Necessary arrangement shall be provided for extending the reading of surge counter, leakage current indication in the SAS.

05.05.00 **PARAMETERS: General (400kV)**

Sl.no	Description	
a)	Nominal discharge current	20kA of 8/20 microsec.wave
b)	Long duration discharge class	3 or 4
c)	Current for pressure relief test	50kA rms
d)	Prospective symmetrical fault current	50kA rms
e)	Low current duration test value	As per IEC.
f)	Partial discharge at 1.05MCOV	Not >than 50pc
g)	System neutral earthing	Effectively earthed
h)	Installation	Out door

05.05.01 400kV Class Surge Arrestor

Sl.no	Description	
a)	Rated Arrestor Voltage	336kV
b)	Minimum Discharge capability	12 kJ/kV
c)	Continuous operating voltage (COV) at 50 deg. C	267rms
d)	Min. Switching surge residual (1 kA)	730 kVp minimum, 780 kVp maximum
e)	RIV at 266 kV (rms)	Less than 1000 micro volts

The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the **Table I** given below..

TABLE-1

Sl.no	Equipment to be Protected	Lightning impulse(kVp)	Switching im-pulse(kVp)
a)	Power Transformer	± 1425	± 1050
b)	Instrument Transformer	± 1425	± 1050
c)	Reactor	± 1300	± 1050
d)	CB/isolator (Ph to ground)	± 1425	± 1050
	Across open contacts	± 1425(± 240)	± 900(± 340)

Surge arrestors shall be capable of discharge on severe re-energisation switching surges on a 400 kV line upto 450 km. length with surge impedance of 300 ohms and capacitance of 11.986 nF/km and over voltage factor of 2.3 p.u. Surge arrestor shall be capable of discharging energy equivalent to class 3 or 4 of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energization.

CLAUSE	TECHNICAL REQUIREMENTS			
05.06.00	TESTS			
05.06.01	Surge arrestors (AIS) shall confirm to all type tests (as applicable) as per IEC 60099-4 and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4. The resistive current drawn by the arrestor for at rated voltage shall be indicated in the routine test report.			
06.00.00	POST INSULATOR			
06.01.00	GENERAL :The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168.			
06.02.00	CONSTRUCTIONAL FEATURES			
06.02.01	Post type insulators shall consist of a porcelain / Polymer 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 shall be accepted. Height of post insulator shall be preferably as given under parameters of this part. The other requirements of insulator as given under auxiliary requirements shall also be applicable.			
06.03.00	TESTS			
06.03.01	In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out.			
06.03.02	In addition to acceptance/sample/routine tests as per IS: 2544, IEC-60168, the following tests shall also be carried out. a) Ultrasonic tests on all cut shells as routine check. b) Visual examination and magna flux test on all flanges prior to fixing. c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing. d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test. e) Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used. f) Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.			
06.04.00	PARAMETERS			
06.04.01	400 kV class Post Insulators			
	Sl.no	Description		
	a)	Type	Solid core	
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b)	Dry and wet one min.power frequency voltage	680kV rms
c)	Dry impulse withstand positive and negative(kVp)	1550rms
d)	Wet switching surge withstand (kVp)	1175 rms
e)	Total min.cantilever strength(kg)	800
f)	Min. torsional moment(kg- m)	600
g)	Total height of insulator(mm)	3650

Note: 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 bidder without any price implication.

07.00.00 REQUIREMENT OF AUXILIARY ITEMS

07.01.00 ALUMINIUM TUBULAR CONDUCTOR

07.01.01 The aluminium tube shall be grade 63401 WP (range2) as per IS 5082. There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.

07.01.02 Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also, the wall thickness and ovality shall be measured by ultrasonic method. In addition, 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.

For 400kV:

a)	size	4"IPS(EH Type)
b)	Outer diameter	114.20mm with no negative tolerance
c)	Thickness of tube	8.51 mm with no negative tolerance
d)	Cross-sectional area	2825.61 sq. mm.
e)	weight	7.7kg/m

07.02.00 ACSR CONDUCTOR

a)	Code and standard & Name	IS:398, MOOSE ACSR
b)	Overall diameter	31.77mm
c)	Strands and wire diameter of	
	a) Aluminium	54/3.53mm
	b)steel	7/3.53mm

BERSIMIS CONDUCTOR :

a)	Code and standard & Name	IS:398, Bersimis ACSR
b)	Overall diameter	35.05mm
c)	Strands and wire diameter of	
	a) Aluminium	42/4.57mm
	b)steel	7/2.54mm



07.03.00 **CLAMPS AND CONNECTORS**

07.03.01 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.

07.03.02 The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S. shield wire.

07.04.00 **INSULATOR STRING HARDWARE**

07.04.01 The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above. In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.

07.04.02 Disc Insulator for porcelain type insulator

The disc insulator shall meet the following parameters:

a)	Type	Antifog type insulator
b)	Size of insulator	255X145
c)	Electro mechanical strength	120KN
d)	Leakage distance(mm)	Min.430 or as required to meet the total creepage
e)	Power frequency voltage- dry & wet	80kV, 50kV

07.04.03 Insulator string (400KV) : **Porcelain type / composite long rod type)**

a)	Creepage distance size	Min.10500
b)	One Minute Power frequency voltage	680KV
c)	Lightning impulse	+/- 1550 KV
d)	Switching impulse	+/- 1050 KV
e)	No of disc.insulator (for porcelain)	25nos
f)	Electromechanical strength	120KN (porcelain)

07.05.00 **SPACERS :** Spacers shall conform to IS:10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.

07.05.01 Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.

07.05.02 In addition to the type tests as per IS:10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.



07.06.00

EARTHING CONDUCTOR:

- a) The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.
- b) All earthing conductors above the ground level shall be galvanised steel only. Refer Annexure-II.

07.07.00

Earthwire for Lightning Protection

a)	Number of strands	7 of steel
b)	Strand diameter	3.66mm
c)	Overall diameter	10.98mm
d)	Weight	583 kg/km approx.
e)	Ultimate tensile strength	68.4 kN minimum
f)	Total cross-sectional area	73.65sq.mm
g)	Calculated d.c. resistance	2.5 ohms/km at 20 deg.C
h)	Direction of lay of outer layer	Right hand

07.08.00

CABLE RACKS INCLUDING SUPPORTS, TRAYS AND ACCESSORIES:

Cable Support Structures & Accessories :

07.08.01

The Contractor shall fabricate and install mounting arrangements for the support and installation of all the cables on GI angles / Cable tray supports in the trenches/ above ground.. These mounting shall be fabricated from structural steel members (channels, angles and flats) of the required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of Part-C0.

07.08.02

Un galvanised M.S. Cable supports shall be painted after installation. The painting shall be in conformity with stipulated in Chapter-C0. All welding works inclusive of the consumables required for fabrication and installation shall be in the scope of the Contractor.

07.09.00

Cable Trays :

07.09.01

Hot dip galvanised ladder type cable trays of adequate width are to be provided for cables in the control room building, out door, above ground cable tray arrangement

07.09.02

Aux. power cables are to be laid on the top tray and DC control cables in bottom trays. Cable trays shall be designed to carry cables load without bending and proper tray supports shall be provided at every 1 mt interval.

07.09.03

Cable trays having power and control cable are spaced at 300 mm and between control cable trays, the spacing is 225 mm. For tray lengths more than 2.5 m coupler plates are to be used for joining the two standard tray lengths. Suitable 'L' and 'T' bends are included under the scope of this contract.

CLAUSE	TECHNICAL REQUIREMENTS			
07.09.04	Cable trays shall be made of 2 mm thick sheet steel having a slotted rung spacing of 250 mm. Height of cable tray channel shall be 75 mm and the standard length of trays shall be 2.5 m.			
07.09.05	All nuts, bolts, washers etc. to be supplied by the Contractor shall be hot dip galvanised after fabrication.			
07.09.06	The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards For Detailed specification Refer Chapter B-10 (cabling , earthing, lighting) of Part-B, Section-VI.			
07.10.00	BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS:			
07.10.01	Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/. The support insulators shall be manufactured and tested as per IS:2544 / IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds. Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.			
07.11.00	CABINETS, BOXES, KIOSKS, PANELS, ETC.			
07.11.01	All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable. They shall meet all other requirements specified elsewhere in the specification.			
07.11.02	Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.			
07.12.00	BAY MARSHALLING BOX			
07.12.01	Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.			
07.12.02	It shall have three separate distinct compartments for following purposes: - To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch. - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs. - 150 nos. terminal blocks in vertical formation for interlocking facility.			
07.13.00	TERMINAL BLOCKS:			
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CLAUSE	TECHNICAL REQUIREMENTS			
07.13.01 07.13.02 07.13.03 07.14.00 07.15.00 07.15.01 07.15.02 07.15.03 07.16.00 07.16.01 07.16.02	They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4. The terminal blocks shall be of 850 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated. Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side: a) All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor b) AC & DC power supply -Two 16 sq.mm. aluminium conductor. c) Circuits Other control circuits - Min. two 1.5 sq.mm. copper flexible conductor. Wiring: All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows: a) All circuits except CT circuits 1.5 sq.mm b) CT circuits 2.5/ sq. mm (minimum number of strands shall be 3 per conductor). CABLE GLANDS AND LUGS : Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components. used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided. The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination. Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent. CONDUITS, PIPES AND ACCESSORIES The 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 reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make			
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CLAUSE	TECHNICAL REQUIREMENTS			
07.16.03	Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.			
07.17.00	Specification of AC bay kiosk shall be as per Annexure-I to this chapter if applicable .			
07.18.00	Type tests All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. ANNEXURE-I			
08.00.00	INSTALLATION			
08.01.00	EARTHING: The earthing shall be done in accordance with requirements given in Annexure-II of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.			
08.02.00	CIVIL WORKS : The civil works shall be done in accordance with requirements stipulated elsewhere in the specification.			
08.03.00	STRUCTURAL STEEL WORKS : The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.			
08.04.00	BAY EQUIPMENT			
08.04.01	The disposition of equipment to be supplied are shown in enclosed single line diagrams and layout drawings.			
08.04.02	The Contractor shall prepare layout drawings and submit the same for approval of the Employer. The approval of drg. shall not absolve Contractor from his responsibility regarding designing & engineering of switchyard and Contractor shall be fully responsible for all works covered in the scope of this specification.			
08.05.00	LIGHTNING PROTECTION			
08.05.01	Direct stroke lightning protection (DSLPP) shall be provided in the switchyard by lightning masts (at least 50 m high) and shield wires.			
08.05.02	Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode. Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system. The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.			
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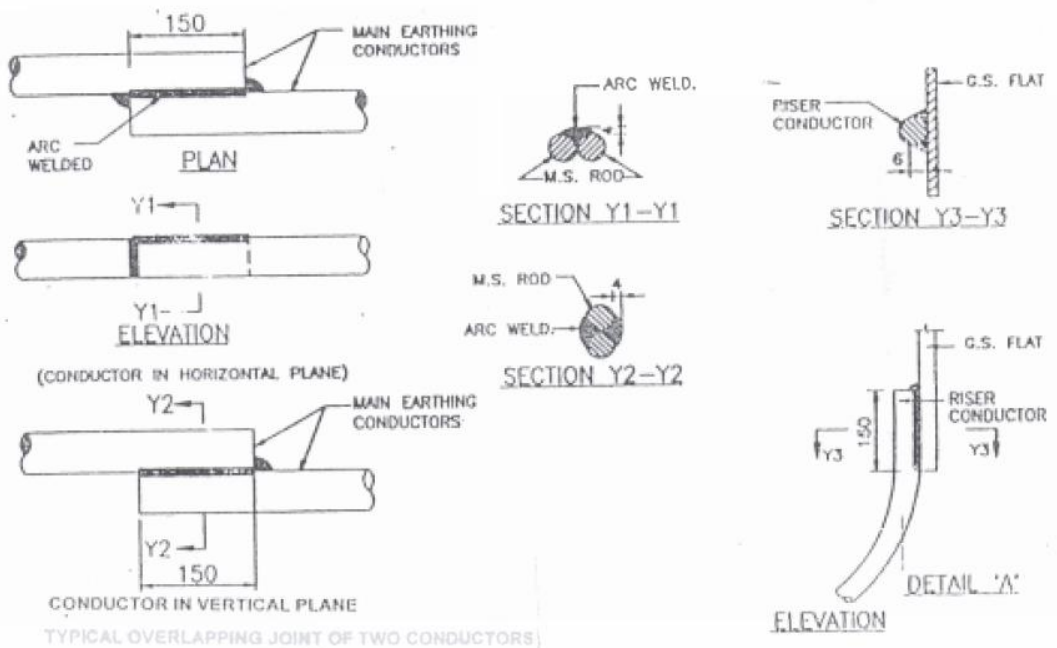
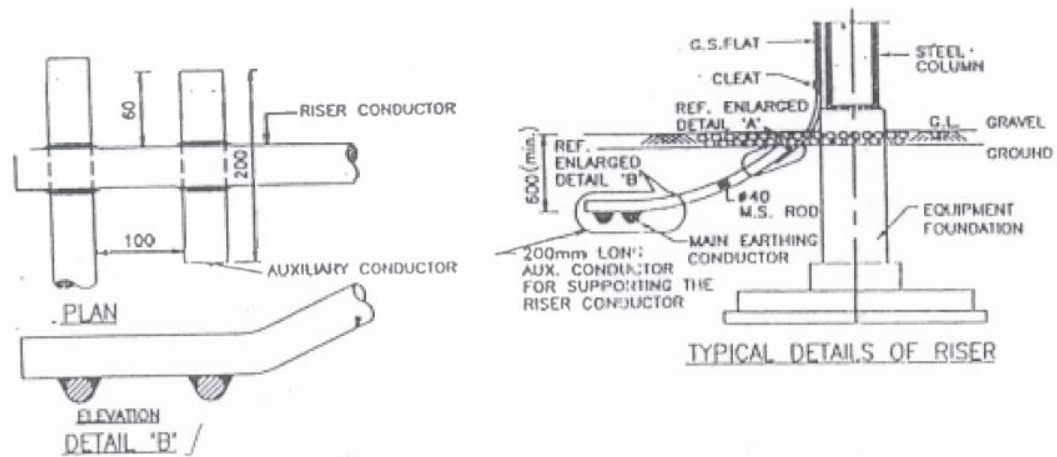
CLAUSE	TECHNICAL REQUIREMENTS			
08.06.00 a) b) c) 08.07.00 08.08.00 08.08.01 08.08.02 08.08.03 08.09.00 08.09.02	EQUIPMENT ERECTION NOTES All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment. The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength. Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation. STORAGE OF EQUIPMENT: Contractor is responsible for the proper storage and maintenance of all materials/equipment entrusted to him. The Contractor shall provide & construct adequate storage shed for proper storage of equipment. Sensitive equipment shall be stored indoors. All equipment during storage shall be protected against damage due to acts of nature or accidents. Contractor shall take all required steps to carryout subsequent inspection of materials/equipment stored as well as erected until the same is taken over by the Employer. The storage instruction of the equipment manufacturers/Engineer-in-Charge shall be strictly adhered to. CABLING Cabling shall be on cable racks, in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification. Cables inside the switchyard shall be laid on bolted GI angle supports/ cable trays at 600mm spacing with separate tiers for control and power cables. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches. Cabling in the control room shall be done on ladder type cable trays with supports at an interval of 2000mm. All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm. CONDUITS, PIPES AND ACCESSORIES : The conductor 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, bushings, reducers, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes etc. The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criterion. 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 portion and entrance of moisture and foreign material. Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling.			
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CLAUSE	TECHNICAL REQUIREMENTS			
	Mild steel pipes shall be hot-dip galvanised. All rigid conduits/pipes shall be of a reputed make.			
08.09.03.	The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS: 458. All tests on hume pipes shall be conducted as per IS: 458.			
08.09.04	Flexible conduits shall be of heat-resistant lead coated steel, water-leak, fire and rust proof and be of PLICA make or equivalent.			
08.10.00	JUNCTION BOXES: Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts and screws required for the erection shall be included in the installation price.			
08.11.00	CABLE SUPPORTS AND CABLE TRAY MOUNTING ARRANGEMENTS →			
08.11.01	Cable trays in the control room are normally provided with embedded steel inserts on concrete floors/walls. The Contractor shall secure supports by welding to these inserts or available building steel structures.			
08.11.02	However, in cases where no such embedded steel inserts are available, the Contractor shall have to secure the supports on wall or floors by suitable anchoring at no extra cost to the Employer. Details of fixing steel plates by anchor fasteners shall be decided during detailed engineering stage. The provision of fixing arrangement including supply of necessary angles etc. shall be included in the installation rates quoted by bidder.			
08.11.03	The cable supports shall conform to the requirements as mentioned in some where in the Specification.			
08.11.04	Insert plates will be provided at an interval of 600mm wherever cables are to be supported without the use of cable trays, while at all other places these will be at an interval of 2000mm. For Detailed specification Refer Chapter B-10 (cabling , earthing, lighting) of Part-B, Section-VI.			
08.11.05	a) EARTHING NOTES FOR SWITCHYARD GENERAL i)			ANNEXURE-II
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b)	cordance 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.			
	DETAILS OF EARTHING SYSTEM			
	Item	Size	Material	
	Main Earthing conductor	40mm dia rod	Mild steel	
	Conductor above ground & earthing leads (for equipment)	75 x 12 G.S. Flat 50 x 6	Galvanized steel Galvanised steel	
	Rod Electrode	:40mm dia, 3000mm	Mild steel	
	G.I. Earth wire	:7/8 SWG	GI	
	Copper Flat (if required)	as per requirement		
	c)	For Step and Touch Potential the following parameters shall be considered		
		i) Current distribution factor – 1 (one)		
		ii) Duration of fault current – 0.5 sec		
		iii) Human body weight – 50kg		
d)	Grid resistance shall be less than 1(one) ohm.			
f)	EARTHING CONDUCTOR LAYOUT			
i.	Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.			
ii.	Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earth mat design calculations.			
iii.	Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations.			
iv.	Earthing conductor along their run-on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.			
v.	Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.			
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CLAUSE	TECHNICAL REQUIREMENTS		
			
vi.	In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future in case equipment is not available at the time of grid installations.		
vii.	Earthing conductors crossing the road shall be either installed in Hume pipes or laid at greater depth to suit the site conditions.		
viii.	Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.		
ix.	Contractor shall also provide interconnection (two interconnection per Unit) of Switchyard Earth mat with the Plant earth mat.		
g)	EQUIPMENT AND STRUCTURE EARTHING		
i.	The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices.		
ii.	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		
iii.	Metallic conduits shall not be used as earth continuity conductor.		
iv.	A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.		
v.	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.		
vi.	Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.		
vii.	Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations.		
viii.	Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead.		
ix.	Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.		
h)	JOINTING: shall be as per enclosed drawing equipment earthing standard drawing details shown in this specification.		
i)	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.		
j)	SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS		
i.	Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.		
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CLAUSE	TECHNICAL REQUIREMENTS			
ii. k) i. ii. iii. iv. v.	Auxilliary earthing mat of 1500mm X 1500mm size comprising of closely spaced conductors at (300mm x 300mm) spacing and at 300mm below ground shall be provided below the operating handles of the isolators. Operating handle shall be directly connected to earthing mat. SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level. Down conductors shall be cleated on the structures at 2000mm interval. Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level. Lightning conductors shall not pass through or run inside G.I. conduits. Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.			
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NOTE : WELDING OF EARTHING CONDUCTOR SHALL BE CONDUCTED IN VERTICAL PLANE WHEREVER POSSIBLE

EQUIPMENT EARTHING DETAILS

STANDARD DRAWING

CLAUSE	TECHNICAL REQUIREMENTS			
9.00.00 9.01.00 9.02.00 9.03.00 9.04.00 9.05.00	SITE TESTING AND COMMISSIONING INTRODUCTION An indicative list of tests for AIS and GIS as applicable is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ 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 along with calibration certificates and shall get the list of instruments approved from the Employer. GENERAL CHECKS - Check for physical damage. - Visual examination of zinc coating/ plating - Check from name plate that all items are as per older/ specification. - check tightness of all bolts, clamps and connecting terminals using toque wrenches. - For oil filled equipment check for oil leakage, if any. Also check oil level and top up. - Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces. - Check cleanliness of insulator and bushings. - All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection. - Check for surface finish of grading rings (corona control ring.) - Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted. CIRCUIT BREAKERS - Insulation resistance of each pole. - Check adjustments, if any, suggested by manufacturer. - Breaker closing and tripping time. - Slow and power closing operation and opening - Trip free and anti-pumping operation. - Minimum pick-up volts of coils - Contact resistance - Functional checking of compressed air plant and all accessories - Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation. - Insulation resistance of control circuits, motor etc. - Resistance of closing and tripping coils. ISOLATORS - Insulation resistance of each pole - Manual and electrical operation on interlocks - Insulation resistance of control circuits and motors. - Ground connections - Contact resistance - Proper alignment to minimise the vibration to the extreme possible during operation. - Measurement of operating torque for isolator and Earth switch - Resistance of operating and interlocking coils. CURRENT TRANSFORMERS - Insulation Resistance Test - Polarity test. - Ratio identification test-checking of all ratios on all cores by primary injection of current. - Dielectric test of oil (wherever applicable). - Magnetizing characteristics test. - Capacitance and tan delta measurement at minimum 10kV.			
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CLAUSE	TECHNICAL REQUIREMENTS			
9.06.00 9.07.00 9.08.00 9.09.00 9.10.00 9.11.00 9.12.00	VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFORMER a) Insulation resistance test. b) Polarity test. c) Ratio test. d) Dielectric test of oil (if applicable). e) Capacitance and tan delta measurement at minimum 10kV. SURGE ARRESTER a) Grading leakage current. b) Resistance of ground connection. c) Resistive current drawn at rated voltage after energization. PHASING OUT The phasing out of all supplies in the station system shall be carried out. 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 surface. e) Dip test on earth conductor prior to use. CONDUCTOR STRINGING AND POWER CONNECTORS a) Physical check for finish b) Electrical clearance check c) Testing of torque by torque-by-torque wrenches on all bus power connectors and other accessories. d) Sag and tension check on conductors. INSULATORS Visual examination for finish damage, creepage distance, etc. WAVE TRAP a) Insulation resistance Test b) Visual check			
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SUB-SECTION-B – 18

CONSSTRUCTION POWER

CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00	GENERAL		
1.01.00	Power shall be made available to the bidder, by the employer as indicated in subsection IIB, Part-A, Section VI of the technical specification. Bidder shall be fully responsible to make all the arrangement beyond these points for receiving & further distribution to meet all construction power requirements for the entire scope including the owner’s construction power requirements indicated in Section-VI, Part-A Sub section –II B of the technical specification.		
1.02.00	The power shall be extended by the bidder to different areas by Armoured cables or overhead lines. All the equipments used in construction power shall ensure full safety to the working personnel and no live parts which are accessible shall be exposed.		
2.00.00	LT DISTRIBUTION BOARDS		
2.01.00	In general, these shall meet the requirements covered in LT switchgear chapter. However, the board shall be provided with outer enclosure so that access to individual compartments, busbar and cable alley shall be available only after the outer door is opened.		
2.02.00	The distribution boards shall be provided with the following: ▪ Pad locking arrangement with hinged door ▪ Sloped canopy to prevent ingress of rain water ▪ Caution notice ▪ Earthing		
3.00.00	CABLES		
	All Cables shall be Armoured and suitable for direct underground buried installation. Cable armour shall be suitable for carrying system earth fault current. HT cables shall be XLPE insulated type.		
4.00.00	EARTHING SYSTEM		
4.01.00	Earthing of all substation equipment and overhead line (if applicable) shall be carried out as per IS:3043. Earthing system shall consist of number of earth electrodes interconnected. Earth electrodes shall be of 40mm dia. galvanized steel pipe, buried in earth pit.		
4.02.00	Number of earth electrodes for LT substation shall be decided considering soil resistivity. However, each LT substation shall have minimum two earth electrodes for neutral earthing, two earth electrodes for body earthing and two earth electrodes for lightning arrester earthing.		
4.03.00	All non-current carrying metal parts shall be connected to earth system at two points, each of 100% rating. Metallic supports, fencing, etc. shall also be connected to earth system.		
4.04.00	Size of earthing conductor shall be selected considering fault current, duration of fault and corrosion rate. Earthing conductor shall be made of galvanized steel strip/wires.		
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.05.00	Overhead lines shall be earthed by continuous galvanized steel overhead earth wire fastened to each pole and connected with earth at minimum three points in every km length. Cross section of earth wire shall not be less than 25 sq.mm.		
5.00.00	INSTALLATION		
5.01.00	The electrical installation shall generally be carried out as per Indian electricity rules and electricity acts.		
5.02.00	For road crossing, protective guarding shall be provided. The clearance for the lowest conductor from ground shall be decided keeping in view the vertical clearance required for movement of vehicles/cranes etc.		
5.03.00	The LT substation area shall be graded and sloped to prevent any stagnation of rainwater.		
5.04.00	The LT substation shall be enclosed by barbed wire fencing on mild steel angle iron posts to a height of not less than 2500 mm with suitable gates for entrance.		
5.05.00	All cable connection parts within the switchgear shall be shrouded with insulating materials.		
5.06.00	The extension boards provided for handheld equipments shall have 3 wire system i.e. phase, neutral & earth as per IE rules. The plug & socket arrangement provided shall be of industrial type with switch provided for proper isolation at the time of insertion or withdrawal of plugs.		
5.07.00	The flexible cable used shall have heavy duty insulation.		
5.08.00	All equipment used for construction activities shall be fed from separate switching/isolating devices.		
5.09.00	All the working areas shall be adequately illuminated for safe working with proper fittings/fixtures. The wire shall be laid with proper fixing without any hindrance to personnel or vehicular movement.		
6.00.00	WORKING PROCEDURES		
6.01.00	Adequate safety equipment's shall be provided to all the workers, like hand gloves, head gear etc. Meggers & testers shall be provided in sufficient quantity.		
6.02.00	Only ITI qualified workers shall be allowed to handle the electrical or electrically operated equipments.		
7.00.00	Quality Assurance: All equipments to be tested for routine tests as per relevant standards. The charges for the same will be deemed to be included in the price of the equipment.		
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SUB-SECTION-B – 19

BATTERY

1.00.00

1. For Ni-Cd Type Battery		
a)	Battery Voltage	220V/110V/48 V DC
b)	No. of Cells	As per Sizing Calculations
c)	Battery type	Stationary Nickel-Cadmium Pocket Plate High discharge type (KPH)
d)	Capacity for five(5)hour rate	As per requirement
e)	Nominal discharge voltage per Cell	1.2 V
f)	Float voltage	As per manufacturer's standards for float application
2. For Lead Acid Plante type Battery		
a)	Battery Voltage	220V/110V/48 V DC
b)	No. of Cells	As per Sizing Calculations
c)	Battery type	Stationary Lead Acid Plante high discharge type
d)	Capacity for ten(10)hour rate	As per requirement
e)	Nominal voltage per cell discharge	2.0 V
f)	Float Voltage	As per manufacturer's standards for float application

DC health monitoring system shall be offered integral with each battery set for Main Plant & Switchyard batteries.

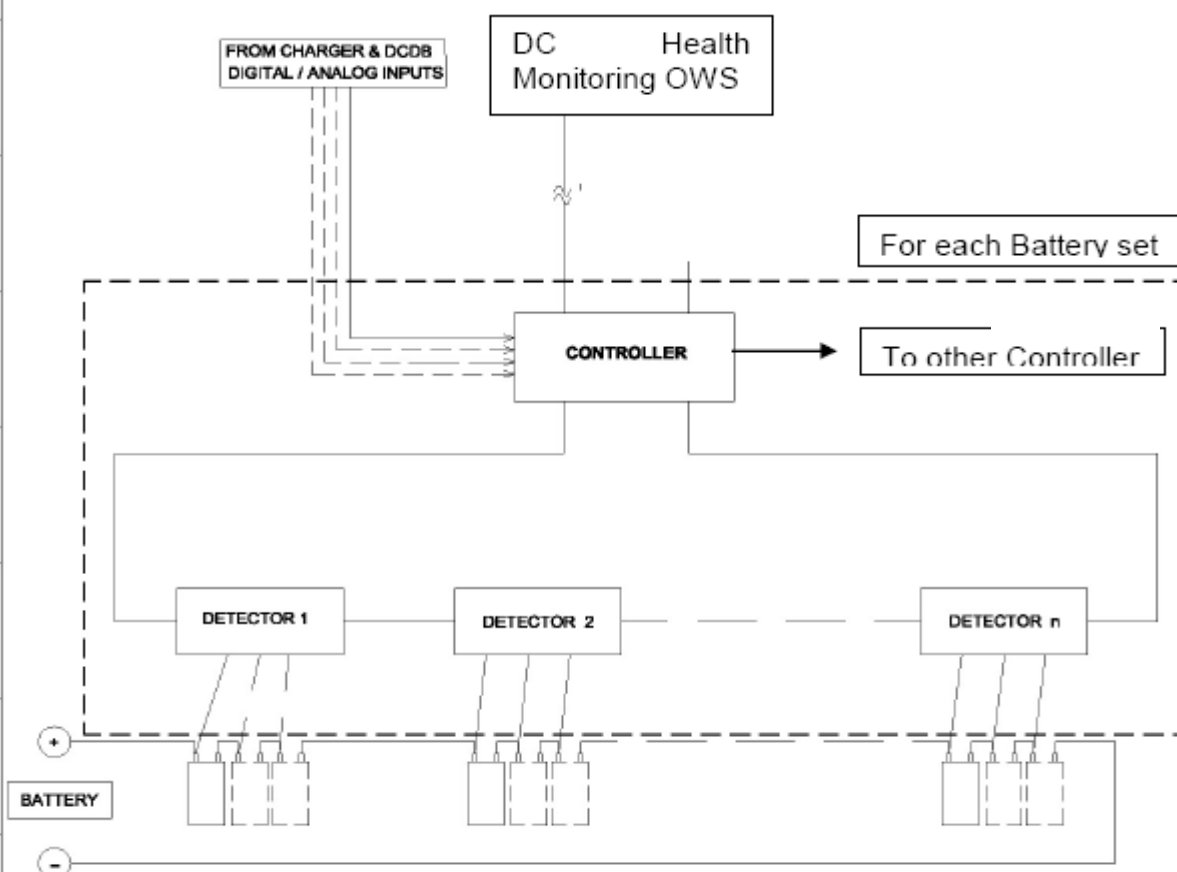
1.01.00

Commissioning of each battery at site shall only be carried out either by the battery manufacturer himself or under the supervision of the battery manufacturer.

CLAUSE NO.	TECHNICAL REQUIREMENTS	
PART-A: 2.00.00 3.00.00 3.01.00 3.02.00 3.03.00	NICKEL-CADMIUM BATTERY CODES AND STANDARDS IEC 60623 / IS 10918 Specification for vented type Nickel Cadmium Batteries. IS 1069 Quality tolerances for water for storage batteries IEC 60993 Electrolyte for vented Nickel-Cadmium cells TESTS For conductance/report submission/validity of type tests, refer Sub Section-IIB, Section-VI, Part A of technical specifications. The Contractor shall submit for Owner's approval the reports of all the type tests carried out as per latest IS-1146(for all applicable tests for containers) / IS-10918 (for Ni-Cd batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier. Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery. Commissioning Checks: Bidder shall submit commissioning test procedure including details of all commissioning check before commissioning the system at site	
PART-B: 4.00.00	LEAD –ACID PLANTE BATTERY CODES & STANDARDS IEC 60896 Stationary Lead-Acid Batteries IS 266 Specification for sulphuric acid IS 1069 Specification for water for storage batteries IS 1146 Specification for rubber & plastic containers for lead acid storage batteries. IS 1652 Specification for stationary cells and batteries, lead acid type (with plante positive plates). IS 3116 Specification for sealing compound for lead acid batteries. IS 8320 General requirements and methods of tests for lead acid storage batteries.	
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159- C-O-M-001	SUB-SECTION B-19 BATTERY AND DC HEALTH MONITORING SYSTEM PAGE 2 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS 6071 Specification for synthetic separators for lead acid batteries. Indian Electricity Rules Indian Electricity Acts			
5.00.00	TESTS			
5.01.00	For conductance/report submission/validity of type tests, refer Sub Section-II B, Section-VI, Part A of technical specifications. The Contractor shall submit for Owner’s approval the reports of all the type tests carried out as per latest IS-1146 (for rubber & plastic containers for lead-acid storage batteries)/IS 1652 (for lead-acid plante batteries). The complete type test reports shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.			
5.02.00	Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of battery.			
5.03.00	Commissioning Checks: Commissioning of each battery at site shall only be carried out either by the battery manufacturer himself or under the supervision of the battery manufacturer.			
6.00.00	DC HEALTH MONITORING SYSTEM			
6.01.00	DC Health Monitoring System shall include microprocessor-based hardware and software to monitor the condition of each battery cell of 220V DC systems battery banks on-line on 24x7 basis. With DC Health Monitoring System it shall be possible to measure & analyse the individual cell and battery parameters so that any damage to battery shall be prevented by pro-active maintenance. A typical Architecture is shown in drawing no. 0000-209-POE- A-002. Each Battery set shall have its own independent DC Health Monitoring System.			
6.02.00	DC Health Monitoring System shall measure and store the following parameters at pre-determined time interval as decided by the employer during detail engineering: a) Each Cell Voltage b) Battery DC Current c) Ambient temperature (1No.) and Cell temperature (1No.) Further, DC Health Monitoring System module shall have provision of accepting at least 6 Nos. of Digital inputs and 2 Nos. of Analog inputs(4-20mA). DC Health Monitoring System shall also be able to store these inputs status for future reference.			
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159- C-O-M-001	SUB-SECTION B-19 BATTERYAND DC HEALTH MONITORING SYSTEM	PAGE 3 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS																			
6.03.00	Technical Parameters <table border="0"> <tr> <td>a)</td><td>Input Power Supply</td><td>230V AC(UPS) / 220V DC</td></tr> <tr> <td>b)</td><td>Voltage Measurement Accuracy</td><td>0.5% or better</td></tr> <tr> <td>c)</td><td>Current Measurement Accuracy</td><td>0.5% or better</td></tr> <tr> <td>d)</td><td>Operating Temperature Range</td><td>0-50⁰ C</td></tr> <tr> <td>e)</td><td>Mounting</td><td>Panel Mounting</td></tr> <tr> <td>f)</td><td>IP Protection</td><td>IP42</td></tr> </table>	a)	Input Power Supply	230V AC(UPS) / 220V DC	b)	Voltage Measurement Accuracy	0.5% or better	c)	Current Measurement Accuracy	0.5% or better	d)	Operating Temperature Range	0-50 ⁰ C	e)	Mounting	Panel Mounting	f)	IP Protection	IP42	
a)	Input Power Supply	230V AC(UPS) / 220V DC																		
b)	Voltage Measurement Accuracy	0.5% or better																		
c)	Current Measurement Accuracy	0.5% or better																		
d)	Operating Temperature Range	0-50 ⁰ C																		
e)	Mounting	Panel Mounting																		
f)	IP Protection	IP42																		
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159- C-O-M-001	SUB-SECTION B-19 BATTERY AND DC HEALTH MONITORING SYSTEM																		
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SUB-SECTION-B – 20

HT LOAD BREAK SWITCH

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	H.T. LOAD BREAK SWITCH AND JUNCTION BOX			
1.00.00	CODE AND STANDARDS			
	IS:3427, IS:2208, IS:9920			
2.00.00	TYPE			
2.01.01	3.3KV/6.6KV/11KV LOAD BREAK SWITCH PANEL			
	Metal enclosed, free standing, indoor, non draw-out type, IP-55 enclosure protection, paint shade: RAL 9002. The panel shall be located in the MCC room of Stacker Reclaimer machine and shall be suitable for the fault level of the system.			
2.02.00	JUNCTION BOX			
	Metal enclosed, free standing, suitable for outdoor location, I.P-65 enclosure protection, paint shade-RAL-9002. 3.3 KV/6.6KV/11KV Junction Box shall be located at the centre of the travel length of Stacker Reclaimer machine and shall be suitable for the fault level of the system.			
3.00.00	TEMPERATURE RISE			
	Temperature rise of busbars shall not exceed 55 deg.C for silver plated joints and 40 deg.C for other joints, over an ambient temperature of 50 deg.C.			
4.00.00	OPERATIONAL REQUIREMENT			
4.01.00	Load break Switch			
	a) Load break switch unit shall be provided with hinged front door and suitable for front execution. The switch shall be mechanically interlocked with the door so that the door can not be opened while the switch is in closed position. b) Constructional details, sheet steel thickness etc. shall be as per technical specification of MCCs. c) The switch unit shall perform satisfactorily even with the vibrations and jerks due to operation of the machine. d) Load break switch shall have shunt trip coil, ON indicating lamp, on/OFF position mechanical indication, internal earth bus and earth switch which shall be interlocked with the main switch. e) Panel shall be identified on front as well as back side by large engraved plate giving detailed feeder description. Identification labels/painted (Not stickers) plates shall be provided inside the panel. f) The panel shall be designed to offer adequate level of safety to operating/maintenance personnel. Means shall be provided to prevent access to the live part to avoid accidents during service as well as maintenance period.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Contractor shall bring out the safety means provided to achieve the same. A detailed instruction plate suitable for wall mounting shall be provided for mounting on wall describing various safety procedure/precautions for safe operation and maintenance. Rubber mats shall be provided in front of the panels.			
4.02.00	H.T. Junction box a) Junction shall be adequately sized to facilitate the HT XLPE cable on one side and EPR insulated trailing cable on the other side. b) Constructional details, sheet steel thickness etc. shall be as per technical specification of MCCs.			
5.00.00	TYPE TESTS:			
5.04.00	Type test reports for the following type tests on HT load break switch panel shall be submitted: 1) Short circuit test 2) Degree of protection test 3) Power frequency withstand test 4) Impulse voltage withstand test			
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SUB-SECTION-B – 21

CONTROL PANEL FOR CHP AHP

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	CONTROL PANELS FOR CHP/AHP			
1.00.00	Local control panels for Coal handling plant: Local control panels for traveling trippers, metal detectors, sump pumps, SM & ILMS, belt weighers, hoists, coal sampling units, hydraulic scoop coupling and dust suppression system. shall be free standing, floor/wall mounting type. Necessary controls, indications and annunciations, as described in CHP control philosophy, for all the above equipment shall be provided in main CHP control desk.			
2.00.00	DESK/PANEL CONSTRUCTION a) Type Fabricated from cold rolled sheet steel Frame thickness 2.0 mm Enclosure thickness 1.6 mm Gland plate thickness 3.0 mm b) Switches AC22 category c) Fuses HRC cartridge with visual operation indicator. d) Name Plates & Labels Each panel shall be identified by a name plate. Panel internal equipment shall be identified by paint marking. Nameplates shall be non rusting metal or 3-ply lamicaid, with engraved lettering and shall be subjected to Employer's approval. e) Grounding 25 x 3 mm copper ground bus to be provided for each panel f) Space heater 240V AC, single phase, thermostatically controlled space heaters to be provided. g) Terminal block 650V grade. clip-on type. h) Type Elmex - CATD type for CTs. Elmex - CSLT for other application. i) Spare 20 percent. j) Wiring 650V grade. PVC insulated stranded copper wire. k) Panel Lighting Each free standing panel shall be provided with a door switch operated fluorescent lamp and a 240V AC plug point. l) Painting Treatment as per IS: 6005. Two coats of lead oxide primer followed by powder painting with final paint shade of RAL 9002.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
	m) Degree of enclosure protection	For panels located in		
SINGARENI THERMAL POWER PROJECT STAGE-II (1X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO.:CW-CM-11159-C-O-M-001		SUB-SECTION B-21 CONTROL PANELS FOR CHP/AHP



SUB-SECTION-B – 22

BUSDUCTS



CLAUSE NO.

TECHNICAL REQUIREMENTS

1.00.00

BUS DUCTS

CODES AND

STANDARDS

ANSI	C 37.20, 37.23, 37.24
BS	3815, 3816
IS	2544, 2705, 3070, 3156, 5082, 8084, 9431
IEEE	298, 32

2.00.00

TYPE

2.01.00

Generator Busduct

Isolated phase busduct, continuous, natural air cooled and positive pressure type, with enclosure of weather-proof, dust tight, non-magnetic minimum flux type.

2.02.00

MV BUSDUCT

Metal enclosed, phase segregated and natural air cooled.

3.00.00

RATING

The Generator Busduct and MV Busduct ratings shall be as per system requirements (B0).

3.01.00

GENERATOR BUSDUCT

Rated Voltage: Corresponding to maximum continuous Generator terminal voltage

Rated Current : As per system requirement.

3.02.00

MV BUSDUCT

Rated Voltage

Equal to Max. continuous system voltage

Rated Current

As per system requirement.

4.00.00

TEMPERATURE LIMITS (considering effect of solar radiations)

Generator Busduct / MV Busduct Conductor/ Joints : 105 deg. C for silver plated joints,

: 90 deg. C for other joints

Enclosure

: 80 deg. C

For outdoor portion the above limits shall be reduced to 97.5 deg. C, 82.5 deg. C and 72.5 deg. C respectively.

5.00.00

FUNCTION

5.01.00

Generator Bus Duct

Generator bus duct shall be provided for Interconnection between generator, generator transformer and unit transformer, Connected to VT and surge protection (SP) cubicles, neutral grounding system and excitation transformer (if required).

5.02.00

Bus Ducts

MV bus ducts shall be provided for Interconnection between transformers and switchgears and between switchgears.

5.03.00

Bus Duct routings below ground level shall not be provided.

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.00.00	OPERATIONAL REQUIREMENTS			
6.01.00	Generator Bus Ducts			
6.01.01	Pressurisation System			
	The pressurization of the busduct shall be done by clean dry air from pressurization system using air supply from plant compressed air system or dedicated compressor/blower. System shall be complete with control and instrumentation, safety features, dryers, filters, blowers etc., after installation at site.			
6.01.02	Busduct shall have earthing pads on all busduct terminations and supporting structures or shall be insulated with single point earth with two distinct conductors.			
6.01.03	Inspection openings shall be provided to allow easy access for installation and inspection of insulators, disconnecting links, terminations & CTs and sealed with neoprene gasket.			
6.01.04	Drain taps with dual stop cock shall be provided for drainage of condensate at the lowest points of IPB.			
6.02.00	MV Bus Ducts			
	Adequately sized galvanised mild steel or aluminum earth bar shall run along the length of busduct. Each enclosure section to be connected to the earthbar at both ends. Both ends of earthbar to be connected to plant earthmat. Alternatively the ground bus may be the enclosure itself, if a continuous electrical path can be provided of the same momentary withstand current rating as the main bus conductors.			
6.02.01	Inspection openings / split covers with reliable sealing with neoprene gasket in grooves shall be provided for allowing easy access for installation and inspection of insulators, disconnecting links terminations and CTs.			
7.00.00	DESIGN AND CONSTRUCTIONAL REQUIREMENTS			
7.01.00	GENERATOR BUS DUCTS			
7.01.01	Enclosure			
	Enclosure shall be weather proof, dust tight, non-magnetic (Aluminium alloy) minimum flux type to permit not more than five (5) percent of total magnetic flux outside enclosure, shall be designed for welded connection and provided with phase enclosure shorting links rated for continuous current shall be provided at busduct termination and flexible joints at bus duct terminations on equipment. It shall be ensured that no enclosure current gets diverted through support structure or equipment body. The portion of the bus duct at the generator end will be subject to vibrations. Busduct enclosure shall not be bolted with generator. A slit of 10-20 mm shall be kept between enclosure and generator flange. Suitable covering shall be provided on the slit to allow escape of hydrogen and avoid dust entry inside the common chamber.			
7.01.02	Conductor			
	The bus conductor shall be of High conductivity, painted aluminium alloy (IS:5082) supported on insulators, designed for welded connections(except at equipment terminations), bolted disconnect links and bolted flexible, flexible connections between bus sections, flexible connection at equipment termination, contacts silver plated and provided with non-magnetic hardware and have high corrosion resistance.			
7.01.03	Flexibles for Conductors to be provided at all equipment termination and in bus duct run to accomodate thermal expansion / contraction, vibration and mis-alignment as also for providing adequate clearances for independently testing the equipment being connected. All Isolated phase busduct termination shall be through copper braided flexibles.			
7.01.04	Painting			
	Conductors and inside surface of enclosures to be treated with mat black paint for efficient heat dissipation			
7.01.05	Bimetallic connectors			
	Shall be provided in case equipment terminals and material of bus conductor are different for non silver plated joints.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
j)	From phase cabinets the VT secondary leads shall be brought to marshalling box having sufficient number of terminals with 20% spare, to accommodate all VT leads. Facility of making star points and undrilled gland plate for cable connections shall be provided in the marshalling box.			
k)	VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks, provided in the instrument transformer marshalling boxes. The facility for connecting to earthing grid shall be provided by the contractor through suitable connectors in the marshalling box with isolating links for testing of instrument transformers.			
7.01.13	Neutral Grounding Cubicle			
a)	The transformer and resistor shall be located in separate cubicles/compartment adjacent to each other. The cubicles shall have hinged access doors capable of being pad locked.			
b)	The transformer cubicle shall be made of angle frame steel construction with formed sheet sides. The resistor cubicle shall be made of angle frame steel construction with hot dip galvanised screen sides. Alternatively it can be painted with heat resistant paint suitable for 250 deg.C. The neutral grounding equipment shall be completely assembled, wired and connected to the neutral bus tap through seal-off bushing.			
c)	The neutral grounding transformer shall be cast epoxy resin type natural air cooled single phase connected between generator neutral and ground.			
d)	The loading resistor shall be formed of non-aging, corrosion resistant punched stainless steel grid element provided with necessary insulation and designed for indoor service for a temperature rise not exceeding 300 deg.C.			
e)	All alarm, protection and indication leads shall be wired up to terminal blocks that shall be mounted in a IP:52 enclosure suitable for flush mounting and having a fully hinged cover with lock.			
7.01.14	Cubicle Construction (V.T. & S.P., N.G. Cubicle Etc.)			
a)	All cubicles shall be fabricated from cold rolled sheet steel for minimum 2mm thick suitably reinforced to ensure structural rigidity. The degree of protection for all indoor cubicle shall be IP:52 except for neutral grounding resistor enclosure which shall be minimum IP:23.			
b)	Space heater, Illumination and Grounding			
c)	Each cubicle shall be equipped with space heater with thermostat, internal illumination lamp, 240 V AC, 5A receptacle. Ground bus suitable for receiving two (2) numbers of 50x6mm galvanised steel flats shall be provided on each cubicle.			
7.01.15	Wiring			
a)	All wiring shall be done with insulated stranded copper conductor of not less than 2.5 sq.mm cross-section with suitable lugs on both sides.			
b)	The wiring inside the bus duct enclosure (i.e. for CT etc.) shall be suitable for operating in the ambient temperature existing inside the bus duct.			
c)	Not more than two wires shall be connected to a terminal. Spare terminals equal in number to 20% of active terminals shall be furnished and these shall be uniformly distributed through out the cubicle CT terminal blocks shall be of stud type and suitable for round type lugs with a facility for isolation, shorting and grounding. It shall be Elmex type CATD or equivalent.			
7.01.16	Name Plate			
a)	Name plates shall be furnished for each equipment, disconnect link, voltage transformer compartment, lightning arrester compartment and fuse block, current transformer TB, Air pressurisation cubicles etc.			
b)	Material for name plate shall be plastic / lamicaid 3mm thick using white letters on black background.			
7.01.17	Finish			
a)	Except for supporting steel structures which shall be galvanised, all equipment including bus duct enclosure shall be finished with an under coats of high quality primer followed by two coats of synthetic enamel paint which shall have a thickness not less than 50 microns.			
b)	The interior surface finish of bus duct enclosure shall be as per manufacturer's standard. The shade of exterior surface shall be shade RAL 5012 for busduct and equipment. The shade of interior surface of cubicles shall be glossy white. The identification tag shall be signal red shade ISC 537 or RAL 3001			
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
c)	Pre-treatment consisting of degreasing, de-rusting etc. shall be done on all fabricated parts before painting of cubicles, cabinets, marshalling boxes and galvanization of steel structures.			
7.02.00	MV Busducts			
7.02.01	Enclosure			
	Aluminum alloy with minimum thickness of 3mm, naturally cooled. Each section shall be welded construction. Sections may be joined through bolted connections. Suitable rain hoods for outdoor joints shall be provided. Adequate number of thermostat controlled space heaters or any other proven arrangement to prevent condensation to be provided.			
7.02.02	Phase barriers			
	MV busduct phase barriers shall be made of Aluminum alloy of minimum thickness of 3.0 mm.			
7.02.03	Conductor			
	Shall be of high conductivity, aluminum alloy or Copper, sections shall be welded or bolted.			
7.02.04	Flexibles for Conductors to be provided at all equipment termination and in bus duct run to accommodate thermal expansion / contraction, vibration and misalignment as also for providing adequate clearances for independently testing the equipment being connected.			
7.02.05	The busduct shall be provided with adequate number of thermostatically controlled space heaters of adequate capacity to maintain the internal temperature above the dew point to prevent moisture condensation within the busduct. Space heaters shall be rated for 240V, single phase, 50Hz AC supply.			
7.02.06	Joints			
	Shall be bolted and flexible joints for conductor and enclosures.			
7.02.07	NOT USED.			
7.02.08	Bimetallic connectors			
	Shall be provided in case equipment terminals and material of bus conductor are different for the non silver plated joints.			
7.02.09	Insulators			
	Glazed porcelain/ high strength epoxy cast resin with a minimum creepage distance of 20 mm/kV. The insulators shall be designed and mounted to facilitate easy inspection, removal & inspection along with provision of conductor fastening by fixed and sliding joints.			
7.02.10	Seal Off Bushing			
	Shall be provided at terminations and wall crossing and at each of the switchgear terminations.			
7.02.11	Wall Frame Assembly			
	Shall be provided wherever bus-duct penetrates plant walls Expansion bellows			
	Neoprene/EPDM or metallic expansion bellows shall be provided on enclosures for thermal expansion, vibrations and misalignment. To be provided at terminations and as required.			
7.02.12	Enclosure supports			
	Shall be provided Hot dip galvanised mild steel support structures to withstand normal operation, vibration, thermal expansion and short circuit forces.			
7.02.13	Minimum clearances for MV busduct shall be :			
	Phase to phase	:	100 mm (for 6.6KV)	
			130 mm (for 11KV)	
			70 mm (for 3.3 kV)	
	Phase to earth	:	90 mm (for 6.6KV)	
			120 mm (for 11KV)	
			60 mm (for 3.3 kV)	
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
7.02.14	Openings covered with louvers backed up with removable dust filters shall be provided at appropriate location to enable the MV busduct enclosure to breathe in a manner so that possibility of condensation is minimised.			
7.02.15	Earthing of Enclosure Adequately sized Galvanised mild steel earth bar shall run along the length of busduct. Each enclosure section shall be connected to the earth bar at both ends. Both ends of earth bar shall be connected to the plant earth mat.			
8.00.00	TYPE TESTS			
8.01.00	A. LIST OF TESTS TO BE CONDUCTED Following type tests shall be conducted on each type & rating of Generator busduct main run, Generator busduct delta run, Generator busduct tap off run and MV busduct. a) Heat run test on an assembly of representative sections and fittings with all types of flexibles, CTs etc. b) Short circuit withstand test (set up same as for heat run) for one (1) sec. duration and current as per system requirement on assembly of representative section with CT's bellows, flexibles. c) Impulse withstand test on an assembly of representative section containing Flexibles, Bellows, Seal of bushing, CT's mounted in position (wherever applicable). d) One minute high voltage power frequency withstand test (set up as for short circuit test). e) Water tightness test as per IS:8084 for generator busduct (set up shall include inspection cover, flanged joint and bellow). f) Air leakage test as per IS:8084 on a typical section(set up shall include inspection cover, flanged joint and bellow) B.LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED Type test reports shall be submitted for following type tests on auxiliary equipment: (a.) Panels, cubicles and marshalling boxes shall be type tested for the degree of protection provided by enclosure as specified below: (1.) For5X-it shall not be possible to insert a thin sheet of paper under gaskets and through enclosure joints. (2.) For 4X-It shall not be possible to insert a one mm diameter steel wire into enclosure from any direction without force. (3.) For 2X-It shall not be possible to insert a twelve (12) mm dia steel wire into the enclosure from any direction without any force. (4.) Test for second digit shall be in line with IS:13947 pt.1			
8.03.00	Routine Test Routine test shall be conducted at manufacturer's works on each busduct and all other components as per relevant Indian Standards & Quality Assurance Sub-section.			
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Details of Current Transformer Parameters

Sl.No	CT Ref	CTR	Accuracy Class	Burden (VA)	Kpv(V)	Max Ie at Kpv/2(mA)/ISF (max)	Max Rct at 75 deg C(Ohms)	Location	Purpose
1	CT-A	27000/5	PS	-	2000	150	5	Neutral Bus Duct	Overall Differential
2	CT-B	27000/5	PS	-	2000	150	5		Generator Protection
3	CT-C	27000/5	0.2	75	-	5	-		Perf Testing, LFPR, Reverse Power
4	CT-D	27000/5	0.2	75	-	5	-		Governor Channel#1, AVR Channel#1
5	CT-E	27000/5	PS	-	2000	150	5		Generator Differential Protection
6	CT-F	27000/5	PS	-	2000	150	5		Generator Differential Protection
7	CT-G	27000/5	0.2	75	-	5	-	Phase Bus Duct	Metering, Governor Channel#2
8	CT-H	27000/5	0.2	75	-	5	-		Governor Channel#3, AVR Channel#2
9	CT-J	27000/5	PS	-	2000	150	5		Generator Protection
10	CT-K1	1600/1	5P20	30	-	-	-	At Tap-Off Bus Duct for UT#1A	UT Back up OC Protection
11	CT-L1	1600/1	PS	-	500	30	6		UT Differential Protection
12	CT-M1	27000/5	PS	-	2000	150	5		Overall Differential Protection
13	CT-K2	1600/1	5P20	30	-	-	-	At Tap-Off Bus Duct for UT#1B	UT Back up OC Protection
14	CT-L2	1600/1	PS	-	500	30	6		UT Differential Protection
15	CT-M2	27000/5	PS	-	2000	150	5		Overall Differential Protection
16	CT-N	As per system requirment/5	1.0	60	-	5	-	NG Cubicle	Stator Earth Fault Protection

Details of Voltage Transformer Parameters

Sl.No	VT Ref	VT Ratio	Class	Burden (VA)	Purpose
1	01VT	(Gen. Terminal Voltage/ $\sqrt{3}$) / (110/ $\sqrt{3}$)	3P/0.2 (Dual Accuracy Class)	100	GRP#1 Protection, Governor Channel#1
2	02VT	(Gen. Terminal Voltage/ $\sqrt{3}$) / (110/ $\sqrt{3}$)	3P/0.2 (Dual Accuracy Class)	100	GRP#2 Protection, Governor Channel#2, AVR Channel#1
3	03VT	(Gen. Terminal Voltage/ $\sqrt{3}$) / (110/ $\sqrt{3}$)	0.2	100	Metering, Governor Channel#3, AVR Channel#2, Synchronisation and Performance Testing