ENGINEERING DESIGN BASIS- ELECTRICAL

FOR

HINDUSTAN PETROLEUM CORPORATION LTD.
VISAKH REFINERY

DHT PROJECT

JOB NO.: 6261

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1.0 SCOPE OF THIS SPECIFICATION

The intent of this specification is to define the requirements for the design, engineering, supply of equipment and materials, erection, testing and commissioning of electrical works, viz. power supply system, lighting, earthing, cabling, etc. for New Visakh Refinery Project within existing the premises of refinery of. M/s.HPCL Refinery , VISAKH.

2.0 CODES AND STANDARDS

2.1 The design and the installation shall be in accordance with established codes, TEIL specifications, sound engineering practices and shall conform to the statutory regulations applicable in India.

2.2 The main codes, standards and statutory regulations considered as minimum requirements are as follows. Latest version of these shall be followed.

i. Statutory Regulations
-Indian Electricity Act.
-Indian Electricity Rules.
-The Factory Act.
-The Petroleum Rules
-The TAC rules.

ii. Codes and Standards,
Some of the bare minimum relevant Standards/ OISD standards are listed as below. However, system/equipment design shall be in line with the latest edition of all applicable standards.

- IS-325 Specifications for Three Phase Induction Motors
- IS 732 Code of practice for electrical wiring installations,
- IS 1255 Code of practice for installation & maintenance of power cables upto & including 33 kV rating.
- IS 1646 Code of practice for fire safety of buildings – Electrical installations.
- IS 1944 Code of practice for lighting of public thoroughfares.
- IS-2026 Oil Filled Transformers
- IS 2309 Code of practice for the Protection of buildings and allied structures against lightning.
- IS 3034 Code of practice for fire safety of industrial buildings Electrical generating and distributing stations.
- IS 3043 Code of practice for Earthing. Application guide for Insulation coordination
- IS 3646 Code of practice for Interior illumination.
- IS-3716 Application guide for insulation co-ordination
- IS 3842 Application guide for electrical relays for AC systems.
- IS 3961 Recommended current ratings for cables.
- IS 4146 Application guide for VT.
- IS 4201 Application guide for CT.
- IS 5216 Guide for safety procedures and practices in electrical

work.

- IS 5571 Guide for selection of electrical equipment for hazardous areas
- IS 5572 Classification of hazardous areas having flammable -gases and vapours for electrical installations
- IS 6665 Code of practice for industrial lighting.
- IS 7689 Guide for control of undesirable static electricity.
- IS 7752 Guide for improvement of power factor - consumer installations.
- IS 8478 Application guide for on load tap changers.
- IS 9676 Reference Ambient Temperature for Electrical Equipments.
- IS 10028 Code of practice for selection, Installation and maintenance of transformers.
- IS 10118 Code of practice for selection, installation and maintenance of switchgear and control gear.
- IS 10561 Application guide for power transformer.
- IS 12360 Voltage bands for electrical installation including preferred voltages and frequencies.
- IS 12459 Code of Practices for Fire Protection of Cable runs
- IS 13234 Guide for short circuit calculations in three phase AC Systems
- IS 13346 General requirements for electrical apparatus for explosive gas atmosphere
- IS 13408 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.
- SP-30 National Electrical Code (NEC) - BIS Publication.
- OISD-RP-110 Recommended practices on static electricity.
- OISD-STD-113 Classification of areas for electric installations of hydro-carbon processing and handling facilities
- OISD-RP- 146 Recommended Practices - Preservation of Idle Electrical equipments.
- OISD-RP-147 Recommended Practices - Inspection & Safe Practices during Electrical Installations.
- OISD-RP-149 Recommended Practices - Design aspects for safety in Electrical system.
- OISD-STD-173 Fire prevention and protection system for electrical installation.
- OISD-GDN-180 Recommended Practices- Earthing and Lightning Protection
- IEC Pub 34 Electric Motors
- IEC Pub72-1&2 Electrical motor
- IEC Pub 76 Power transformers
- IEC Pub 79-0 Electrical equipment for hazardous area general rules.
- IEC Pub 79-10 Classification of Hazardous area
- IEC Pub 79-1 Flameproof electrical equipment
- IEC Pub 79-2 Pressurized safety equipment
- IEC Pub 79-14 Electrical installations in gaseous explosive atmospheres

- IEC Pub 86 Evaluation and classification of electrical insulation
- IEC Pub 529 Enclosure protection classification (IP)
- IEC 947-4-1 Low voltage switchgear and control gear.

2.3 IEC/CENELEC /any other standard may be followed as applicable for the country of origin.

3.0 SYSTEM DESCRIPTION

3.1 General

3.1.1 The overall power receipt, generation and distribution system for the New Visakh Refinery Project is indicated in the key single line diagram E-6261-051001.

3.1.2 Refer Electrical design data (Doc.No.A-6261-098-002) for details.

3.2 Operating Philosophy

3.2.1 New Captive Power Plant comprising of three nos. generators i.e. one STG(1x17MW) and Two GTG (2x31.5 MW) with combined output of 80 MW have been envisaged to cater the new loads of phase-1 & 2.Generator terminal voltage will be 11 kV, which will be further stepped up to 33 kV and connected to new power plant switchgear located in SS-70.

The Refinery uses 132 kV grid power to back up the generation. This Grid power will be hooked up at 33 kV level through 132 / 33 / 33kV transformer.

Another tie at 33 kV will be provided at the 33 kV Grid switchgear bus of the 132 kV switchyard covered under 2 X 25 MW CPP Expansion Project under VRCFP. This tie will be connected to new power plant switchgear and will generally be OFF. ***HOLD***

3.2.2 Both the generators will operate on 3+0 configuration with grid hook-up. When one machine is not available for maintenance or shut-down; the other two machine will cater to both phase-I and phase-II loads with the help of appropriate load shedding and grid support. Eventually, this will get influenced if other generators share need based power requirement. It is also possible to import the surplus power of 7MW, from the other system in controlled environment.

3.2.3 A Diesel Engine generator set is envisaged for facilitating black start of the power plant.

3.2.4 Substation - ***71*** will receive power at 33kV level. The power will be further distributed at 6.6kV by 33/6.9kV transformers and up to 415V level by means of 6.6/0.433kV transformers. ***All other substations / MCC room will receive 6.6kV power supply***

3.2.5 The 33kV, 6.6kV switchboards and 415V PCC/PMCCs shall have two bus sections each with auto/manual changeover scheme.

3.2.6 Auto changeover shall be initiated when one Incomer opens on sustained under voltage while the other Incomer voltage is healthy. In case of simultaneous loss of supply on both the incomer, circuit breaker shall remain in their previous state. ATS operation shall be locked in case of any fault. Manual changeover shall be done with momentary paralleling of two Incomers only when they are synchronized (to be checked through check synch. relay) in the following cases.

- For taking one transformer out of service during a planned maintenance.
- For bringing both the transformers into service after restoration of incoming supply.

3.2.7 The following unit sub-stations are envisaged to take care of power distribution of the entire complex. Dedicated substation requirement shall be reviewed during detailed engineering stage.

No.	Substation No.	Phase-I or II	Used for Plant
~~***i)***~~	~~***Substation - 70***~~	~~***Phase-I***~~	~~***Power plant and Distribution***~~
ii)	***Substation - 71***	***Phase-I***	***DHT+HGU(Train-1)+FGATU+ SRU+ATP+SWS***
iii)	Substation - 72	Phase-II	MHCU+HGU(Train-2)+EO System
iv)	Substation - 73	Phase-II	DCU+ATU+Merox
~~***v)***~~	~~***Substation - 74***~~	~~***Phase-I***~~	~~***SRU+ATP+SWS***~~
~~***vi)***~~	~~***Substation - 75***~~	~~***Phase-I***~~	~~***Cooling Water***~~
vii)	***Substation/MCC room***	***Phase-I***	***N2 plant + IA dryer***
viii)	***Substation / MCC room***	***Phase-I***	***DM plant+ BCW+Raw Water plant***
Ix	***Substation / MCC room***	***Phase-I***	***Boiler Package***

3.2.8 Substation -***71*** will receive two no. of 33kV feeders each from ***132kV GIS*** substation. Each feeder will be designed to feed 100% load of the substation. Power for all other substations will be provided through 6.6kV feeders from ***existing / SS-71 substation.***

3.3 Operating Philosophy For Emergency Power Supply System

3.3.1 ***415V emergency Power supply from existing / new DG set*** has been envisaged to cater for the total emergency power demand of Lighting, Plant Communication, UPS, battery chargers and other loads if any which shall be connected, to Emergency PMCC/MCC. ***For other substation / MCC room***

415V emergency power will be made available from SS-71 / existing substation.

3.3.2 Incase of complete blackout i.e. power failure at grid & Generator, the emergency DG set shall feed the total emergency load automatically.

3.3.3 Synchro-check feature shall be provided in the emergency PMCC for smooth transfer of load from DG to normal supply and vice versa. Synchronization facility shall be provided in emergency PMCC.

3.3.4 In addition to the Emergency DG Sets mentioned above, one additional Emergency DG set is envisaged for CPP Start-up as shown in the Overall SLD. (Dwg No: E-6261-051001.)

HOLD

3.3.5 The rating of the Emergency DG Set at CPP shall be finalized considering the Auxiliary load requirement of Largest Generating set, Largest Motor to be started on EMDG and other emergency loads of CPP plant like loads required for safe shutdown, safe coasting, cooling etc. and lighting, UPS, battery charger plus spare margin of 10%.

3.4 Site Conditions

Refer to document no. A-6261-098-002 of Electrical design data..

4 SYSTEM DESIGN PHILOSOPHY

4.1 General

The electrical system shall be designed to provide.

- Safety to Personnel and equipment during both operation and maintenance.
- Reliability of Service.
- Minimal fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Elect. supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Maximum interchangeability of equipment.
- Fail safe feature.
- Energy efficient equipment.
- Suitability for applicable environmental factors
- Protection against Electro magnetic induction (EMI) shall be considered while designing battery charger/UPS/EPABX/PA/SCADA/Heater/Exciter/ LT & HT switchgears

4.2 Area classification and equipment requirements

4.2.1 All the areas within the battery limits shall be classified for the degree and extent of hazard from flammable materials as applicable. Classification of Hazardous areas for all locations shall be done in accordance with the following clauses.

4.2.2 All the electrical equipment installed in hazardous areas shall be selected as per Cl.11.0 of Electrical design data (Doc No: A-6261-098-002) and shall meet the requirements of relevant IS or IEC or CENELEC or the country of origin.

4.2.3 All electrical equipments for hazardous areas shall be certified by CIMFR (CMRI), PTB, BASEEFA, UL or FM or equivalent independent testing agency for the service and the area in which it could be used. Necessary approvals from CCE and DGFASLI shall be obtained by the CONTRACTOR for all equipment installed in hazardous area. All indigenous flameproof equipments shall have BIS license.

4.2.4 Selection of Electric equipment in Hazardous area.

a) When certified equipment is not available to meet the specific requirements of the dictated area, equipment certified for more onerous conditions should be employed. For example, in Zone 2 area where equipment certified for use in Zone 2 is not available, then equipment certified for use in a Zone 1 area should be employed.

b) The electrical equipment installed in a hazardous area shall be designed to operate with a maximum surface temperature not greater than the maximum temperature given in the table below.

i) For flameproof apparatus, the surface to be considered is the external surface.

ii) For other type of protection internal surface shall also be considered, if the explosive gas atmosphere has access to them. (E.g. Ex'e')

iii) According to IS-5572 the apparatus shall be marked with the symbol indicating the class, as shown in table below.

MARK OF CLASS To ON EQUIPMENT	LIMIT To OPERATION (oC)	CLASS To OF EXPLOSIVE GAS ATMOSPHERE IN WHICH THE EQUIPMENT CAN OPERATE
T1	450o	T1
T2	300o	T1-T2
T3	200o	T1-T2-T3
T4	135o	T1 to T4
T5	100o	T1 to T5
T6	85o	T1 to T6

4.3 Power system design

The distribution system shall be designed in accordance with this design basis, taking into account all possible factors affecting the choice of the system to be adopted; such as required continuity of supply, flexibility of operation, Operational costs, reliability of supply from available power sources, total load and the concentration of individual loads.

4.4 Capacity of Electrical Plant

All the components of the electrical system shall be sized to suit the maximum load under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and an additional margin shall be taken into account for intermittent service loads. if any. The amount of electrical power consumed by each area shall be calculated for its operation at the design capacity.

4.5 Voltage Drops

The maximum voltage drops in various sections of the electrical system shall be within the limits stated in the following table.

4.5.1 Full load operating conditions (Steady state):

SL. NO.	SYSTEM ELEMENT	MAX. PERMISSIBLE VOLTAGE DROP
a)	Bus duct or cable between generator, transformer Secondary and HV Switchboard or PCC/PMCC	0.5%
b)	Cables between PCC/PMCC and MCC or auxiliary Switchboard i) MCC/Auxiliary Switchboard near PCC/PMCC ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% 2%
c)	Cables between HV Switchboard and HV motor	3%
d)	Cables between PMCC/PCC and motor	5.5%
e)	Cable between MCC (situated near PCC/PMCC) and motor	5%
f)	Cable between MCC (situated remote from PCC/PMCC)and motors	3%
g)	Cables between auxiliary Switchboard and Lighting Panel	1% to 1.5 %
h)	Circuit between lighting panels and lighting points	4%
i)	Electrical UPS Outgoing circuits	5%
j)	Electrical DCDB Outgoing circuits	5%
k)	DC Supply Circuits (Instrumentation)	(See Note -1)
l)	UPS Outgoing Circuits (Instrumentation)	(See Note -1)

Note-1

Minimum voltage available across any instrument in the field shall be as per instrumentation design basis. Distribution system for instrumentation Power shall be designed accordingly.

In case of any conflict between electrical design basis and instrumentation design basis, the letter shall govern regarding instrumentation power supplies.

4.5.2 Motor Start-up/Re-acceleration Conditions

SL. NO.	SYSTEM ELEMENT	MAXIMUM PERMISSIBLE VOLTAGE DROP
a)	Cable Between HV Switchboard and Motor	5%
b)	Cable Between MV Switchboard (PCC/PMCC/MCC) and Motor	15%
a)	At Bus bars of worst affected HV Switchboard. Startup of large HV Motor with other loads on the bus or reacceleration of group of HV Motors.	15%
b)	At Bus bars of worst affected MV Switchboard. Startup of large MV Motor with other loads on the bus or reacceleration of group of MV Motors	5%

NOTES:

1) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or re-acceleration of the motor (even with the motor fully loaded, if required) without causing any damage to the motor.

2) For medium voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or re-acceleration.

3) For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or re-acceleration.

4.6 System Earthing

4.6.1 System earthing for incoming supply and primary / secondary HV distribution system shall be as per design data. The 415V system neutral shall be solidly earthed.

4.6.2 For resistance earthed systems, the resistance values shall be chosen to limit the earth fault current to a value which shall be sufficient for selective and reliable operation for earth fault protection system, while ensuring minimum equipment damage during an earth fault. However, the value of limited earth fault current shall generally not exceed 50% of transformer or generator full load current.

4.7 Short Circuit Capacities

Each short circuit interrupting device shall be designed to have rated service breaking capacity (Ics) equal to or higher than the maximum value of short circuit current calculated, at its location. The related switchgear shall withstand the above maximum available fault current for a minimum period of one second. The sizing of high voltage cables shall be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system in

addition to the maximum anticipated load current. For cables connected in parallel, each cable of the circuit shall be designed to withstand the short circuit current for the given duration.

4.8 Insulation System

The insulation of electrical facilities shall be designed considering the system voltage, the system neutral earthing and the over voltages resulting due to system fault, switching or lightning surges. The insulation coordination between the electrical equipment and the protective devices shall be done in line with IS: 3716. Lightning arrestors and surge absorbers shall be provided where necessary.

4.9 Protection Schemes

4.9.1 The protection system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage which can occur due to Internal or external short circuits or atmospheric discharge.

b) Uninterrupted operation of those parts of the system which are not affected by the fault.

c) Personnel and plant safety.

4.9.2 The minimum requirements of protective relays shall be as per enclosed Electrical design data. In addition to above any other protective relay & auxiliary relays if required shall be provided to fulfilled functional requirements.

4.9.3 All plant feeders which are connected to captive power plant generation bus shall be provided with differential protection. The CT arrangement /Locations for differential protection shall be such that overlapping zones are formed for differential protection provided for HV feeders, Bus couplers tie feeders etc.

4.9.4 Protective relays shall be of numerical type with latest version with non volatile memory control and communication with SCADA system on IEC 61850 protocol for all breaker operated feeders and IEC 103 (Public Domain)/MODBUS/IEC61850 protocol for other non breaker operated motor feeders , compatible to communicate with SCADA and ECS. Relay shall support functions like relay parameterization, disturbance recorder etc.It shall be possible to set or operate the relay from the front facia. Lock out relay shall be provided separately and it shall be conventional type with hand rest facility.
Numerical Protection Relay shall have RS 485/FO Port with and G3 confirming coating on PCBs.

4.9.5 Special protections for any feeder such as differential, restricted earth fault, directional distance power relay etc, shall also be through separate relay having communication facility with SCADA.

4.9.6 Auto Change Over Scheme

4.9.6.1 Switchgears (HV, MV) to be supplied shall have 2 incomers and 1 no. Bus coupler. Normal operation shall be with 2 incomers 'CLOSE' and the bus coupler 'OPEN'. Upon opening of any of the incomers due to loss of power supply, bus coupler shall be closed through automatic bus transfer, thereby restoring power supply to affected section. Once the power supply is resumed / fault is cleared on affected incomer, closing of the incomer and opening of the desired breaker (any of the incomers or bus coupler) shall be done manually, with momentary paralleling of the two incomers through synchro check relay.

4.9.6.2 The bus coupler change over scheme shall have two separate relays for monitoring the bus healthy and unhealthy conditions. Preferably healthy bus relay shall be set at 80% setting and un-healthy bus relay shall be set at 40% or less.

4.9.6.3 For switchboards having Auto transfer facility , opening of incomers on under voltage shall be inhabited if the voltage dip is transient and is experienced on both the incomers simultaneously.

4.9.6.4 All MCCs shall be provided with two incomers and one bus coupler of 800Amps ACB. The incomer and buscoupler ACB shall be without any protection release. Electrical interlock shall be provided between all the ACBs.

4.9.6.5 Down stream bus coupler change over scheme shall not be blocked on operation of pilot wire / cable / transformer differential protection.

4.9.6.6 Auto change over scheme shall be PLC logic frame in the Numerical relay to eliminate/minimize unreliable contact multiplier/relays. Auto/Independent/ Manual and Trip Selection Switches shall be provided.

4.9.6.7 Auto transfer shall be inhibited, if the operation of under voltage relay is due to opening of PT fuse/MCB

4.9.7 Process trip & Electrical trip shall be through different master trip relay (86). Process trip relay shall have manual reset flag & self reset coil. Electrical Master relay flag & coil shall be manual reset type. Both the Master trip relay actuation shall be recorded in Sequence of Events through Numerical relay.

4.9.8 In case the necessary indications/Measurements are not possible by means of Relay/Load Managers then necessary I/O modules, transducers shall be provided.

4.10 Metering Scheme

4.10.1 The minimum metering requirements for the various switchboards shall be as per Electrical design data (Doc No: A-6261-098-002). The metering requirements of UPS, DC systems, rectifiers, shall be as per the respective equipment specs.

4.10.2 Any other metering equipment, if felt necessary to meet system requirement shall be provided by the Contractor. All meters shall be digital communicable type.

4.10.3 All the breaker operated feeders shall be provided with separate Load Managers. The Load managers shall be connected to S/S SCADA system through separate Metering LAN. All motor feeders from 22kW and up to 55 kW shall be provided with communicable load managers.

4.10.4 Transducers shall be self powered type.

4.11 Emergency Power Supply

4.11.1 The emergency power supply system shall be provided to feed the following
- electrical loads essential for the safe shutdown of the palnt.
- Emergency lighting,
- Plant Communication System.
- Telephone System
- Fire alarm system,
- D.C. Supply system.
- UPS system,
- Lube oil pump motors or any other motor load as per process requirements
- SCADA and ECS System

4.11.2 Diesel Engine Driven Pumps shall have PLC based control for interlocks and Auto Start. Use of contactor is not permitted.

4.12 Uninterrupted Power Supply (UPS)

4.12.1 Uninterrupted power supply system shall be provided for meeting critical loads as per instrumentation design basis and other loads that cannot withstand a momentary interruption in voltage.

4.12.2 Following loads shall be connected to the UPS system.

- Critical instrumentation and control
- Critical communication equipment
- Critical security equipment
- Computers
- Annunciation panel
- Siren

Each UPS system shall have at least 20% spare capacity and each ACDB shall have at least 20% spare feeder of each rating.

4.13 Plant Communication System

4.13.1 The plant communication system generally conforming to specs.6261- N-171.

4.13.2 System shall consist of the following :
- Microprocessor based central exchange installed in the main process control room and power plant control room.
- Power supply system
- Master station along with external loudspeakers, microphone etc.

- Desk type call station along with microphone and external loudspeaker for installation in Buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external oudspeaker.
- Interconnection of two exchanges for communication between master call stations.

4.13.3 Paging speakers provided in areas having high ambient noise levels shall produce a paging sound level at least 6dB above the anticipated ambient level. Field stations shall be capable of operating in areas of high noise without any inference. Separate battery and battery charger shall be provided for each exchange.

4.13.4 System shall have provision for addition of 20% field call station and loud speakers in future.

4.13.5 Process units & CPP shall have separate exchange located in Master control room & CPP control room respectively

4.13.6 Redundancy shall be maintained for power supply (In-built supply + Normal/emergency supply), line modules, Power supply modules.

4.13.7 Public address system shall be suitable for integration with CCTV, FA, EPABX, Gas detection system and HVAC system.

4.13.8 All the spare line modules shall be wired to receive cards in future.

4.14 Telephone System

4.14.1 A telephone system comprising of EPABX, telephones and Radio Pagers shall be provided for all process and non process buildings in plant & outside communication system.

4.14.2 Required no. of telephone instruments shall be provided in various rooms in all the buildings.

4.14.3 Spare capacity 20 % shall be provided in the EPABX to cater for the requirements of future expansion.

4.14.4 Digital EPABX shall be suitable for integration with CCTV, FA, PA systems. It shall also be compatible for mobile interface.

4.14.5 Since large number of lightning strokes occurs during monsoon season, Vendor shall advise special precautions to be taken for protecting the telephone system against lightning strokes.

4.15 Fire Detection And Alarm System

4.15.1 The technical requirements of Fire Alarm system shall conform to ‘and ‘Standard Specifications for Fire Alarm System’ Doc No. : 6261-N-175.

4.15.2 Fire alarm system shall be micro-processor based intelligent, analogue addressable type.

4.15.3 System shall be designed to provide necessary audio visual signals at control room with mimic panel and repeater control panel. The system shall be hooked with main fire control panel located at the main fire control station.

4.15.4 System shall comprise of individual break glass type manual call points, smoke/ heat detectors, main panel, hooter, siren, battery charger, response indicator, exits sign and other hardware.

4.15.5 Battery and charger shall be provided for each panel separately, rated for complete fire alarm system operation for failure of power supply for at least 48 Hours. FRLS armoured cables shall be used for the system.

4.15.6 Detectors and Manual call points shall be connected in separate loop.

4.15.7 Response indicators shall be provided for detectors located in hidden location.

4.15.8 The manual call points shall be provided at strategic with access of 60 meters. Along all exit routes & rods

4.15.9 Electrical sirens shall be provided at strategic points to cover entire plant area.

4.15.10. System shall have provision for addition of 20% detectors, manual call points in future.

5.0 SUB-STATION *(MAIN S/S, SMALL S/S, MCC ROOM)* DESIGN

5.1 The sub-station shall be located in a safe-area close to the load centre. Consideration shall be given to vehicular traffic or any other factor that might affect the operation of the sub-station.

5.2 Sub-station floor shall be raised above grade level and the space below the switchgear room shall be utilized as cable cellar. The cable cellar floor shall be 300 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 2.5 m below beam and shall house all cable trays and their supports.

5.3 Cable cellar should have RCC trench meant for all HV cables (33kV and 6.6kV cables). GI trays shall be used for routing MV power and control cables.

5.4 Communication cables shall be routed well away from power cables, on a suitably sized GI tray for distribution

5.5 In the small ~~*MV*~~ sub-stations & MCC rooms (if provided) shall be elevated at least by 1M by compacting the soil so that the bottom of the cable trench within sub-station is above the surrounding grade level.

5.6 A separate entry of 3 x 3 m with rolling shutter shall be provided for drawing in all equipment for erection. The main entry for operating personnel shall be provided

with double door system. The Substation shall also have an emergency door opening outwards.

5.7 An air-conditioned control room shall be provided in the sub-station for locating the operator station, SCADA Station equipment, VFD panels, battery charger, UPS panels etc.

5.8 Sub-station wall adjacent to the transformer bays shall be 355 mm thick in case of brick construction or 230 mm thick in case of RCC construction.

5.9 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization.

5.10 Battery banks shall be located in a separate adequately ventilated room in the sub-station buildings, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.0 m height shall have acid/alkaline resistant protective material coating/tiling. Light fittings in this room shall be chemical resistant type.

All electrical equipment installed in the battery room shall be flameproof type if there is possibility of emission of Hydrogen / Hazardous gases.

5.11 The battery rooms shall be provided with minimum two exhaust fans and louvred opening in opposite wall/door. UPS system and other power electronics equipment e.g., variable speed drive panels shall be located in air-conditioned room.

5.12 Each Sub-station shall have fire fighting equipment, first aid boxes and other safety equipment as per statutory requirements. Mats of required voltage rating shall be provided in front of switchboards.

5.13 Equipment like oil filled transformers, neutral grounding resistors, reactor and HV capacitor bank etc. shall be located in bays adjacent to the sub-station building. All bays shall have well drained floor, surfaced with gravel or other suitable material. All bays shall have MS gates, main gate for removing the transformer and wicket gate for person entry. The gates shall be lockable. Partition walls between transformer bays and the ends of the last bay shall be of fireproof type and shall extend at least 600 mm above the height of the equipment. Height of the bay shall be decided so as to facilitate maintenance and easy removal of equipment and requirements of natural ventilation.

5.14 Oil immersed transformers with oil capacity exceeding 2000 liters, shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 liters, provision shall be made to drain away the oil to a separate waste oil tank/pit located away, through suitable drain pipes of 150 mm or 200 mm in diameter.

5.15 One set of accessories consisting of cell testing voltmeter, spanner, face shield, PVC apron, acid proof boots & rubber gloves shall be provided in each battery room.

5.16 The substation building shall be sized to take care of present and future needs and to maintain adequate clearances between equipment for ease of maintenance.

The following minimum clearances around various equipment shall be maintained:

a)	Front clearance for HV switchboard	2500 mm
b)	Front clearance for all other switchboards/panels	2000 mm
c)	Rear clearance for panels having maintenance Access from front only	Less than 200mor more than 750mm
d)	Rear clearance for panels requiring maintenance from rear	1500 mm (For HV) & 1000 mm (For MV)
e)	Side clearance between two switchboards mm (but not less from nearest obstruction than twice the Width of each panel)	1500
f)	All around clearance for transformers / NGR / capacitor bank / series reactor	1000 mm
g)	Battery rack to wall clearance for	
	- Signal row. Single/double tier	100 mm
	- Double row, single tier	100 mm
	- Double row, double tier	750 mm
h)	Battery rack to rack clearance	750 mm
i)	Front clearance for wall mounted equipment	1000 mm
j)	Front clearance for operation station Annunciation /control panel.	2500 mm
k)	Head Room Clearance below Bus duct or any other overhead equipment	2000 mm

Minimum vertical clearance above the top of highest equipment shall be minimum 1500 mm measured from bottom of roof slab and minimum 500 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling minimum clearance of 750 mm shall be provided between false Ceiling & top of any equipment. On either side of HV & MV panels, space shall be provided to install one (1) vertical panel for future expansion/requirement.

5.17 The DG sets shall be located in separate building than the substation in a safe area to reduce noise level in substation. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room If required. Stacks shall be provided for the exhaust /flue gases as per the statuary norms.

5.18 Fire prevention and protection system for sub station building and electrical

installations shall conform to OISD-STD-173.

5.19 The toilet with waste disposal system acceptable to local authorities shall be provided at the substation building.

5.20 Telephone sockets shall be provided at appropriate locations and 5/15 Amps sockets shall be provided at every 15 meter distance in the switchgear room

5.21 Substation building shall have air-conditioned operator room, operator change room, toilet with soak pit, a store room as a minimum.

5.22 Layout of substation shall comply with OISD regulations, IE rules, TAC regulations and any other statutory rules in general.

5.23 SS-71 shall be Air-conditioned and all other Substation / MCC room shall be pressurized. It shall be ensured that the inlet air of the pressurized system / Air-conditioning shall be free from the moisture and hazardous mixtures. Positive pressure shall be maintained inside the substation / MCC room

5.24 Substation lighting (Switchgear room ,Cable cellar room) shall be controlled by push button switches located ***outside*** at the entrance and exit points.

5.25 All drains and pits around the substation and transformer area shall be covered with heavy duty RCC slab.

5.26 All substations, UPS rooms, battery charger / battery rooms shall be provided with at least 25% space for future expansion.

~~***5.27 Substation lighting controls shall be through switches provided outside, at the entrance of the building.***~~

5.28 The Substation-71 building shall be multistoried type. The building shall consist of the following

1) ***Ground Floor – Cable Cellar, Transformer bay***
2) ***First Floor – Switchgear Room***
3) ***Second Floor – Cable Cellar***
4) ***Third Floor - Switchgear Room***

6.0 EQUIPMENT SPECIFICATION

6.1 General

6.1.1 All electrical equipments shall be brand new and of make & type as per the vendor list. The final make and type of equipments shall be subject to approval of Owner/ PMC

6.1.2 The contractor shall use TEIL standard specifications & particular specifications for various equipments. However for equipments where specifications have not been attached, the contractor shall use their equipment specifications developed based on the project requirements specified in the bid package and good engineering

practices prevalent in petroleum Industry and to ensure satisfactory operational and maintenance requirements.

6. 1.3 The equipments shall in general conform to the latest revision of Indian Standards, IEC/Other International Standards applicable for the country of origin of the equipment.

6.1.4 All other equipment shall be subjected to routine and acceptance tests as per the applicable specifications and all type test certificates shall be submitted as a minimum. The type test certificates for all electrical equipments shall not be more than 5 years old at the time of contract award**.** In case this criterion is not met, then the type test shall be conducted before delivery of equipment without any additional cost & schedule impact to owner. Contractor shall specify in their purchase specification the requirement of conducting other special tests/type tests, which are envisaged to be conducted for various electrical equipment.

6.1.5 All equipment shall be epoxy painted and colour shade of all electrical equipment shall be as below.

-Outdoor located equipments : 632 as per IS: 5
-Indoor equipments : 631 as per IS: 5

6.1.6 Special tools/tackles required for operation & maintenance of equipments shall be supplied.

6.1.7 HV motors/power feeders, PMCC fed motors and power feeders shall be under Load Shedding scheme. Necessary wiring shall be made for tripping the above with a Load Shedding command from ECS.

6.2 Transformers

6.2.1 The oil cooled transformers shall be conforming to Specs. 6261**-** N-121A

6.2.2 The lighting transformer shall be dry type conforming to specs**.** 6261-N-202

6.2.3 All transformers except lighting transformers shall be three phase oil immersed, double wound type suitable for outdoor use.

6.2.4 The Lighting transformer shall be three phase, double wound, and dry cast resin type suitable for indoor use.

6.2.5 The ratings of transformers shall be decided based on the following criteria:-

ONAN transformers :- The rating shall be equal to or higher than 115% of maximum simultaneous demand envisaged.

ONAN / ONAF transformer :- The ONAN rating shall be equal to or higher than the maximum simultaneous demand envisaged. The ONAF rating shall be equal or higher than 125% of ONAN rating.

Lighting Transformers :- The lighting transformers shall be sized for 125% of maximum simultaneous demand of the corresponding lighting distribution board.

Lighting Transformer shall have off circuit tap changing facility to adjust voltage level.

6.2.6 Sizing factor for standby and intermittent loads shall be considered as 0.1 and 0.5 respectively.

6.2.7 The percentage impedance of each transformer shall generally be as per Indian standards .

6.2.8 100% standby transformer shall be provided in all unit offsite & utility substations, ~~***normal lighting transformer***~~ unless otherwise specified.

6.2.9 Maximum rating of 33/6.9kV and 6.6/0.433kV transformer shall be limited to 25/31.5 MVA and 2 MVA respectively. In case requirement exceeds above these rating, multiple no. of transformer along with switchboard shall be included.

6.2.10 The rating and no. of various transformer shall be decided based on the following criteria and in addition to that rating shall be decided based on largest motor start up capability and all possible plant operating conditions with respect to process design and plant operation such as running of normal and standby loads together. The transformer feeding a bus section of PMCC/PCC (HV, MV) shall be capable of feeding the entire load connected in both the sections of its switchgears i.e. during normal operation with bus coupler open, it should be loaded to 40 to 45 % of the capacity at its maximum efficiency point. During failure of the other section transformer say section 2, the section-1 transformer shall take the full load with temperature rise within the limits. Voltage drop with the transformer feeding the entire load and starting the biggest motor or reacceleration of group of motors connected to its switchgear shall be suitably considered for designing the transformer.

6.2.11 The oil filled transformers shall be provided with minimum following accessories in addition to those listed in IS: 2026.

Accessories	11/34.5kV	33 /6.9 kV	6.6/0.433 kV
Bi-directional On Load Tap Changer (OLTC)	-	X	
Off ckt. Tap changer	X		X
Sampling valve	X	X	X
Conservator drain valve	X	X	X
Tap oil filter valve	X	X	X
Drain cum bottom filter valve	X	X	X
Pressure relief valve	X	X	X
WTI with contacts	X	X	X
OTI with contacts (Dial type)	X	X	X
Double float Buchholz relay	X	X	X
Bi-directional flat roller	X	X	X
Marshalling box	X	X	X
Cross channels with towing lugs	X	X	X

Separate neutral bushing outside terminal box	X	X	X
Disconnecting chamber	X	X	X
Inspection cover	X	X	X
Neutral CTs	X	X	X
Oil Level Transmitter	X	X	X
Magnetic Oil level Gauge	X	X	X
Air bag for conservator	X	X	X

6.2.12. Transformer shall be of low losses type. Usually no. load and load losses shall be optimized for operation around 40 to 50% of their ONAN rating with efficiently not less than 99.3% and 90.0% of power and distribution transformer respectively at 0.8 power factor.

6.2.13 The transformers above 10MVA shall be provided with nitrogen purging system as a part of transformer fire protection

6.3 Switchgears (HV/MV)

6.3.1. The HV switchboards shall conform to specs.6261-N-131

6.3.2 The MV switchboards shall conform to specs.6261-N-133A

6.3.3 All switchgears and associated equipments fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. However, generator incomer shall be rated at least equal to 110% of the continuous rating of generator and transformer incomer shall be rated at least equal to forced cooled rating of transformer or 125% of ONAN rating as applicable.

6.3.4 Bus tie circuit breakers shall have rating higher of the following

a) Largest incoming circuit breaker
b) Maximum running load on either side of bus section.

In no case shall the tie breaker rating be less than the bus-bar current ratings.

6.3.5. All 33 kV switchgear shall be air insulated type. All switchgear shall have rating at least equal to the maximum demand plus provision for 10% future load.

6.3.6 Spare outgoing feeders shall be provided in all switchboards. At least one number of each rating and type or 10% whichever is more shall be provided as spare on each bus section.

6.3.7 Circuit breakers/contactors controlling motor feeders shall have rating, at least 25% above the maximum continuous rating of the connected motors.

6.3.8 Starters for all motors shall be provided in the switchboards located in substation. However special cases like MOVS, EOT cranes, etc. they shall be located in the field near the motors.

6.3.9 Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles may be

connected to one power feeder.

6.3.10 For motor above 5.5 KW, CTs shall be provided in the switchgear for feeding ammeter on the local push button station and digital ammeter on panel.

6.3.11 For MCCs /PDBs /LDBs, the maximum rating of busbar shall be limited to 800Amps.For panels having two Incomers, necessary tie Breaker shall be provided for bus sectionalizing. ACB shall be used for incoming and tie feeders and these shall have suitable interlocks.

6.3.12 Rating of each power control centres and emergency switch board shall be limited to maximum 3200A and fault level limited to 50kA for one second.

6.3.13 Emergency Switchgear incomers and Bus coupler breaker shall be 4 pole type.

6.3.14 All motor feeders shall be provided with type 2 co-ordination.

6.3.15 Care shall be taken during design stage for contactor operated motor feeders with long control circuit leads. Suitable RC circuit shall be provided.

6.3.16 Marshalling cabinet shall be provided to cater to DCS/SCADA interface requirements. Terminals for DCS/SCADA input and output contacts shall be segregated and separate terminal blocks shall be provided. Marshalling cabinet shall have provision for terminating incoming and outgoing multicore copper conductor armoured cables with required cores and numbers.

6.3.17 Power factor improvement capacitor bank shall be provided at 6.6 kV ~~***and 415V PCC ,***~~ so as to maintain required power factor of 0.95 at 6.6 kV and ~~***0.9 at 415V level.***~~

6.3.18 Circuit breakers/ switch fuse units for capacitors shall, have a current rating of at least 135% of the capacitor rated current. Circuit breakers capacity to interrupt applicable capacitive current shall be specifically verified.

6.3.19 The switchboard components viz. Circuit breakers, main horizontal and vertical bus- bars, bus-bar joints, bus-bar supports etc. shall be designed to withstand the maximum expected short circuit level for a minimum time of 1 sec.

6.3.20 Numerical protection, control & monitoring system shall be provided for all HV equipments, HV,MV switchboards and Generators. The relay shall be as per clause 2.13 of specification 6261-N-131 of HV Switchgear and Engg. Specifications for Numerical Relays (Doc No: 6261-N-203). The electronic parts of the Numerical Relay shall be coated with G3 Conformal coating.

6.3.21 i Each feeder in HV switchboard shall have stand-alone protection, metering and control. Relays and control shall be programmable type**.** Alphanumeric display shall be provided on control console on the panel to display metering. However manual closing/tripping of the breaker shall be done by dedicated breaker control switches with pistol grip handle.

ii All interlocks ***/ control / signals*** between electrical switchboards/ panels and DCS/Instrumentation panels shall be hardwired.

iii All relays shall be numerical type providing comprehensive protection as required for each feeder. Relays shall be provided with serial communication interface. It should be possible to program the relays from the work station as well as relay face.

iv No analog meters shall be provided in, HV and MV switchboards & Generator control panels. CT and PT signals shall be used to provide measurements. In case calculated values for measurement of MW, MVAR, MWH, PF, and frequency are not possible proper transducer shall be provided for alphanumerical display on the panel. Serial communication interface shall be provided to communicate measurement data to remote.

6.3.23 Dual CT ratios for differential protection shall not be considered and will not be acceptable. Separate CT shall be included for differential protection.

6.3.24 Earthing trucks shall be provided for bus and cable earthing in each switchboards. Breaker handling trolleys (2Nos.) shall be considered for substation.

6.3.25 All incomers shall have ON/OFF/TRIP indication lamp and trip switch for sending end breaker. All breaker shall have ON/OFF/TRIP/ TRIP HEALTHY indication lamps etc.

6.3.26 All Medium voltage switchboards (PCC,MCC,EPC,ASB etc.) shall be of one make only.

6.3.27 All HV switchgears shall be provided with IR inspection windows for taking thermography.

6.3.28 Incomer of LDB's shall be provided with automatic voltage conservation system for energy conservation.

6.4 ECS and SCADA System (HOLD)

6.5 Bus Duct

6.5.1 The bus duct shall conform to standard specs.6261- N-125

6.5.2 The bus bar material shall be Aluminum or copper.

6.5.3 Busbar of bus duct shall be of same material as that of switchgear.

6.6 Battery, Battery Charger and DCDB

6.6.1 The battery & chargers used shall conform to specs 6261-N-135.

6.6.2 Each battery bank, charger & DCDB shall have at least 20% spare capacity to meet future requirements.

6.6.3 Each DCDB shall be provided with at least 20% spare feeders.

6.6.4 Fast acting fuses shall be used with proper co-ordination in charger outlet, DCDB incomer, and all outgoing circuits.

6.6.5 One number cell booster shall be provided which shall be capable of charging any type of cell in the substation/UPS room.

6.6.6 Auto start facility for charger shall be provided to avoid manual start of charging during system under voltage condition.

6.6.7.1 Battery monitoring and management system inclusive of capacity test shall be provided with battery charger.

6.6.7.2 Battery charger shall be with 12 pulse rectifier. Allowable rms ripple voltage shall be max 1% of nominal output voltage in battery charger.

6.7 Uninterrupted Power Supply System

6.7.1 The UPS systems shall conform to specs 6261- N-137.

6.7.2 Each UPS systems shall have at least 20% spare capacity to meet future requirements.

6.7.3 Each ACDB of UPS system shall be provided with at least 20% spare feeders.

6.7.4 The UPS shall be provided with fault diagnostic unit.

6.7.5 Auto start facility for charger shall be provided to avoid manual start of charging during system under voltage condition.

6.7.6 The UPS shall be provided with isolation transformers at its input and output.

6.7.7 The UPS system used for Instrument supply shall be earthed or Un earthed as per Instrumentation Requirement.

6.7.8 Fast acting semi conducting fuses shall be used & properly co-ordinatinated for UPS outlets ACDB and all outgoing feeders to distribution boards.

6.7.9 Cell booster shall be provided for each AH capacity of battery cells for each system.

6.7.10 UPS system shall have single battery bank with 100% battery load

6.8 Emergency Diesel Engine Generator & Diesel Engine driven pumps

6.8.1 The DG set and accessories shall conform to specs.6261- N-129

6.8.2 Emergency diesel engine driven generator shall be provided to feed the emergency loads of the complex as defined in Cl. 4.11 above.

6.8.3 The DG set shall have 10% spare capacity. .

6.8.4 The DG set shall be equipped with auto on mains failure scheme (AMF).The Auto-Mains failure scheme shall be PLC Based.

6.8.5 The transient reactance of generator shall be decided so as to enable DOL starting of largest motor.

6.8.6 The emergency set shall be procured as a complete package and shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations (e.g. the starting of the largest rated motor) The unit shall be complete with necessary starting equipment associated control panel and shall be suitable for remote starting.

6.8.7 The regulation of generator voltage shall be automatic and necessary instruments for metering viz., Ammeter, Voltmeter, frequency meter, Kwh meter, Power factor, hour run counter etc. Shall be included in control panel. Warning of abnormal conditions shall be incorporate prior to automatic trip to prevent unnecessary shutdown.

6.8.8. Emergency D.G. set shall have auto starting arrangement but only with manual switching off features fail to start annunciation shall be provided, in case the engine fails to start.

6.8.9 The load shall be switched on to the generator only after the requisite voltage build-up. The generators set shall be provided with complete protection against overloads, short-circuit , ground faults, excitation failure, prime mover failure and shall include other connected instrumentation interlocks.

6.9 Neutral Grounding Resistor.

6.9.1 The neutral grounding resistors shall conform to specs. 6261- N-163

6.9.2 The resistance value of the NGRs shall be chosen to limit the earth fault current to a value, which shall be sufficient for selective & reliable operation of earth fault protection system, while ensuring minimum equipment damage during an earth fault. However the value of the limited earth fault current shall not exceed 50 % of the full load current of corresponding transformer/ generator.

6.10 Motors

6.10.1 The HV (Above 1.1 kV) motors shall conform to specifications 6261- N-111A.

6.10.2 The MV (Up to 1.1V) motors shall conform to specifications 6261- N-111B.

6.10.3 All motors shall be suitable for direct on line starting, unless otherwise any other method is required by process. Please refer Electrical Design Data for detailed requirements of starting methods of motors.(Doc No: A-6261-098-000)

6.10.4 Only standard output (kW) rating of motors (applicable for country of origin) shall be used.

6.10.5 All motors shall be continuous maximum rated with possible exception of crane and hoist motors and engine starting motors, which may be rated for the envisaged duty cycle.

6.10.6 ***All MV motors shall be Energy efficient type-1 only and HV motors shall have high efficiency.***

6.10.7 Space heaters shall be provided for the motors above 30kW.

6.10.8 Motors with anti-condensation heaters shall have a separate terminal box provided for the same.

6.10.9 Motor rated more than 750KW shall be provided with sleeve bearing. Motors above 1000 KW shall have temperature detectors for bearing & winding temperature along with temperature scanner.

6.10.10 Ingress of water through motor shaft/bearing housing shall be prevented using superior felts located inside the bearing housing .Motors shall have FRP canopies fully covering motors including bearing housing

6.10.11 All motors with VFD application shall be provided with insulated bearings.

6.10.12 Motors which are to be installed inside the acoustic enclosure shall be flameproof type.

6.10.13 Starting time calculations shall be based on operating conditions specified on purchase requisition eg. Open valve conditions/ Closed valve conditions , at No load / under load as applicable.

6.10.14 Motor hot withstand time at 100% voltage shall be 2sec. (Min) more than the starting time of the motor at 80% voltage.

6.10.15 Vendor to provide in plant training and at manufacturer's works for synchronous motor for both engineers and no-engineering staff. Training shall include design, installation, commissioning, maintenance and trouble shooting of electrical equipment at site and training of Owner's persons at Vendor / sub-vendor's work.

6.10.16 Vendor shall furnish site acceptance testing (SAT) procedures from the equipment supplier and get it approved before carrying out the same at site.

6.10.17 HV motor vendor shall submit the report for tandelta test and signature analysis.

6.10.18 Noise level for HV and MV motors shall be as per relevant standards.

6.11 Annunciation Panel

6.11.1 An audio-visual annunciation panel shall be provided to monitor the switchgear and other electrical equipments. The panel shall be freestanding or wall mounting type.

6.11.2. Detailed annunciation schedule shall be based on but not limited to the following.

a) HV Switchgear

- Breaker-wise fault trip alarm
- Status of Auto-changeover scheme
- Trip circuit status for breakers
- Differential relay operation alarm
- Transformer trouble alarm
- DC supply failure alarm (Bus wise)
- PT secondary MCB trip alarm for all line & bus PTs

b) MV switchgear

- Incomer / Bus coupler fault trip alarm.
- Status of Auto-changeover scheme
- Bus-wise group fault trip alarm for outgoing feeder breakers
- D.C. supply failure alarm (Bus-wise)
- PT secondary MCB trip alarm for all line & bus PTs

c) Operating status/fault conditions for UPS system
d) Operating status/fault conditions for DC supply system
e) Operating status/fault conditions for DG sets.

6.11.3. Annunciation panel shall be complete with acknowledge, test and reset pushbuttons. 20% spare window for future use shall be provided in the panel. Generally annunciation panel shall be fed from the UPS system.

6.12 Cables

6.12.1 The power & control cables shall conform to specs.6261- N-153 and 6261- N-151.

6.12.2 HV power cables shall be with stranded aluminum Conductor, dry cured XLPE insulation, conductor & insulation screens, PVC inner sheath armour & FRLS PVC outer sheath. The screen for the HV cables shall withstand earth fault current for one second.

6.12.3 MV power cables shall be with stranded aluminum / Copper conductor, XLPE insulation, PVC inner sheath, armoured and overall FRLS PVC outer sheath.

6.12.4 All control cables shall be with stranded copper conductor, ***XLPE*** insulation, ***PVC*** inner sheath, armoured & FRLS PVC outer sheathed.

6.12.5 The minimum cross sectional areas for cables shall be as per enclosed Electrical

design data. (Doc No: A-6261-098-002)

6.12.6 The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system Earthing and short circuit withstand criteria. The derating due to ambient air temperature ground temperature, grouping and proximity of cable with each other, thermal resistivity of soil etc. shall be taken into account.

6.12.7 Cables connected in parallel shall be of the same type and cross-section. Further, each length of cable connected in parallel shall be designed to withstand short circuit current for the given duration

6.12.8 All power and control cables shall be in continuous lengths (except for long feeders) without any splices or intermediate joints in no case joints shall be located in hazardous areas. The cable used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals.

6.12.9 All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for actual rated capacity of the equipment as well as harmonic currents as applicable. Cable for capacitor banks shall be sized for 130% of the rated capacitor current.

6.12.10 Separate control cables shall be used for each of the following

- CT secondary circuit.
- PT secondary circuits.
- Interlock/inter trip circuits.
- Pilot wire differential circuits.
- DC signals between instrumentation & electrical equipments.
- AC signals between instrumentation & electrical equipments.
- Switchboards to each local control stations.

However, the above stipulation will not apply to control cable for local control stations with ammeter.

6.12.11 Multicore / multipair control cables shall have minimum 20% spare cores.

6.12.12 Screened control cables shall be used for all VFD drive applications.

6.12.13 Control cables from Interface junction box to switchgear should be screened type.

6.12.14 All signal cables shall be FRLS type.

6.12.15 All LT joints shall be with cold compound.

6.13 Control Stations

6.13.1 Each motor shall be provided with a control station in- the field unless other wise a specific requirement form the Package vendor.

6.13.2 The control station enclosure shall have suitable protection for site conditions (such as flameproof, weather proof. dust proof, corrosion resistant etc.). FRP

Canopy shall be provided to protect outdoor control stations against rain.

6.13.3 The control station shall include the following equipment as per individual requirement:

- Start/stop push button or TNC switch (for breaker operation)
- Ammeter for All motors having rating above 5.5 kW
- Local /Remote Switch
- Cable glands.

6.13.4 Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc.

6.13.5 All control stations shall be provided IP 65 protection.

6.13.6 The flameproof control stations & industrial type control stations shall conform to standard spec. 6261-N-112B & 6261- N-112A respectively.

6.13.7 Motors installed at elevated platforms (such as cooling tower fan etc.) shall be provided with a stop push button with LED type indicating lamp at ground level in addition to the one near the motor.

6.13.8 Weatherproof emergency pushbutton station near each power and distribution transformer room shall be to trip transformer feeder in case of emergency. The switch shall be with pad lock feature.

6.14 Convenience Receptacles

6.14.1 The flameproof plugs receptacles and hand lamps shall conform to specs 6261-N-192D & C

6.14.2 The enclosure shall have suitable protection for site conditions specified (explosion proof, weatherproof, dust proof, corrosion resistant) etc. All convenience and welding receptacle to be used in hazardous area shall be Ex'd' type.

6.14.3 Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 30 meters length of trailing cable to any point in the process area and substation. These shall be rated for 63A suitable for 415V, 3 phase system with a scraping earth.

6.14.4 Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 meters length of cable to all manholes of process equipments. Other important area in the process unit shall be rated for 15A, 240 V single phases with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. In hazardous areas, hand lamps shall be rated for 24V. Accordingly 240/24V transformers shall-be provided either in the plug or in a separate flameproof enclosure.

6.14.6 Adequate no. of receptacle (63A, 415V 3P+N+E) shall be provided in compressor, blower area to provide power to portable equipment. Minimum rating

of receptacle provides for portable equipment shall be 63A, 415V, 3P+N+E.

6.14.7 Outdoor receptacles shall be provided with FRP canopy.

6.15 Motor Operated Valves

6.15.1 The MOVs shall be provided with integral starters and shall conform to Instrumentations specifications for MOV.

6.15.2 Necessary contacts and other interfacing devices for integration with control room shall be provided as per process requirement.

6.16 HV & MV Variable Speed Drives

6.16.1 The HV Variable speed drives & MV Variable speed drives shall conform to spec.6261- N-136A & 6261-N-136 respectively.

6.16.2 System shall be highly reliable ,efficient, and shall provide high power factor , low harmonic distortion, low noise level etc.

6.16.3 The system shall be suitable for load characteristics, continuous speed variation and shall be with soft start feature. Drive shall be able to accelerate the load over full speed range (0-100%) with incoming line voltage regulation of 10%.

6.16.4 The VSD panel supplied shall be of proven make.

6.16.5 Only 4-20mA analog hard wired signal from and to DCS/SCADA shall be considered for VSD speed control.

6.16.6 Motor Space heater supply has to be provided from VSD panel. Critical cards which are essential for operation of VSD shall be provided with redundancy.

6.16.7 Measures shall be taken to contain Electromagnetic interference and harmonics arising out of VSDs. Screened internal cabling shall be used for power and control.

6.16.8 Motors of rating above 2 MVA shall have soft starter to limit the starting current with bypass arrangement. Breakers for isolation of VFD shall be provided for carrying out maintenance jobs when motor is running.

6.16.9 If process requirement calls for the variable speed on continues basis, then VFDs shall have redundancy with on-line changeover.

6.16.10 If process requirement does not call for the presence of VFD all the time, i.e. when the system operates at the rated speed, then provision for running the motor on bypass shall be made available.

6.16.11 The offered system shall be suitable for operation from DCS as per process requirement and also shall be able to interface with substation data concentrator.

6.16.12 Due consideration shall be given in design of the variable speed drive system for long length of cables. Out put filters, chokes, motor insulation, cable voltage grades, cable capacitance etc. shall be selected accordingly. Approximate distance between motor and variable frequency drive shall be 450Mtrs. However exact distance shall be informed to the vendor during detailed engineering.

6.16.13 The manufacturer for the variable frequency drive system must have supplied a similar system with similar technology as being offered for the job. At least one of the systems with similar technology as being offered must have completed six months of successful operation as on the date of offer.

6.16.14 Incase any filter etc. are required to limit total harmonic (As per IEEE519) on input side of switchboard due to VFD's being fed from this board same shall be in vendor's scope.

6.16.15 Vendor to provide in plant training and at manufacturer's works for VVFD for both engineers and no-engineering staff. Training shall include design, installation, commissioning, maintenance and trouble shooting of electrical equipment at site and training of Owner's persons at Vendor / sub-vendor's work.

6.16.16 Vendor shall furnish site acceptance testing (SAT) procedures from the equipment supplier and get it approved before carrying out the same at site.

6.16.17 All PCB cards used in VVFD system shall be conformal coated.

6.17 Synchronous Generator and Excitation System (HOLD)

7.0 INSTALLATION DESIGN PHILOSOPHY

7.1 Cabling System

7.1.1. Cabling work shall generally be carried out as per Specs. 6261-N-301 and cl.7.0 of Electrical design data. (Doc No: A-6261-098-002)

7.1.2 Additionally all cable trays, trenches and road crossings shall be sized to accommodate 20% additional cables for future use.

7.1.3 RCC lined trenches shall have suitable drainage arrangement to avoided water collection

7.1.4 Cables connected in parallel shall run together, so that their length remains the same and these shall be suitably secured so as to avoid stresses arising due to short circuits.

7.1.5 RCC cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave a hazardous area or enter a control room or substation. Pipes laid for mechanical protection shall be sealed at both ends. In case of direct buried, cable route markers shall be installed at every 30 m interval all along the cable routes and also at cable joints and locations where the direction of cable trench changes.

7.1.6 Separate trays shall be provided for HV/MV power, control & plant communication cables. Separate trenches shall be provided for HV/MV cables. Separate cables for cables shall be provided for AC and DC signal/control circuits.

7.1.7 All cable trays and accessories shall preferably be prefabricated, hot dip galvanized for tray system design, in addition to self load and wind forces, load for design of supports for cable trays shall be minimum 85kg/m Also one man load of 75kg shall be considered in the centre of top tray in a span of 3 metres.

All structural steel design shall be as per Indian standards.

Bends, tees, reducers, crosses, droppers etc. shall have the required bending radius as required for various cable sizes with a minimum of 300mm

7.1.8 Instrument & communication cables shall not be laid in the same trench along with electrical cables. The overall cable layouts shall be designed for minimum interference between signal and power cables.

7.1.9 The armour and semiconductor screen of single core cables shall be earthed at one end. The continuity of armour & semi conductor screen shall be broken at each joint . Strategic locations in process, utility areas where specific safety/shutdown operation are to be carried out. The unearthed end of armoured & screen shall be insulated.

7.1.10 Junction boxes may be used for power circuits in electrical equipments where the equipment terminal box can not be designed for customer designed cable size and same shall be subject to PMC / Owner's approval.

7.1.11 Straight through joints shall be avoided to the maximum extent possible. However in no case the same shall be installed in hazardous areas.

7.1.12 Total cable route connected to FW motors starting from main receiving station to FW pump house shall directly buried.

7.1.13 ERCs shall be provided for all roads, to the maximum extent possible for routing to avoid road cutting at a later date.

7.1.14 Underground cable routes shall be designed to avoid close pipe crossing and adjacent runs with underground pipelines. A distance of at least 30cms between cable and pipe shall be maintained. Cables shall preferably cross underneath buried pipelines.

7.2 Earthing And Lightning Protection System

7.2.1 Earthing and lightning protection system shall be executed as per specs 6261- N-301 and cl.8.0 of Electrical design data.

7.2.2 The minimum size of main earth grid around the substation and in plant area shall be 75x10 sq. mm.

7.2.3 All utility/process pipelines shall be earthed on entering or leaving the hazardous areas, except where conflicting with the requirements of cathodic protection. In addition, steel pipe racks shall be earthed at every 25 metres. Earthed continuity shall be ensured across all flanges in process unit & other hazardous areas. Equipment located remote from main earth network, may be earthed by means of individual earth conductors and earth electrodes.

7.2.4 As a minimum, lightning protection shall be provided for the equipment, structure and buildings as per IS-2309. self conducting structures may not be provided with aerial rod and down conductors, they shall however be connected to the earthing system at minimum two points at the base. An independent earthing network shall be provided for lightinng protection and this shall be bonded with the main earthing network only at the buried electrode.

7.2.5 Earthing conductor and connection points shall be as given below

Sr. No	Particulars	No.of Earthing Points (Minimum)	Earthing Conductor Size & Specification
1	Main Earth grid buried underground as well as along main cable routes and in substation & in plant area	-	75 X 10mm G.I strip
2	Sub earth loop along cable trays	-	50 X 6mm G.I strip
3	Sub earth loop along street / Fence lighting cable routes	-	50 X 6mm G.I strip
4	Equipment such as tanks,vessels & Heat exchangers etc.	2	50 X 6mm G.I strip
5	Transformers	2	75 X 10mm G.I strip
6	DEG SET	2	75 X 10mm G.I strip
7	HV (6.6kV) Switchgear	2	75 X 10mm G.I strip
9	LV Switchgear	2	75 X 10mm G.I strip
10	Lighting and power panels	2	1 X 25 Sqmm YY Cable
11	Control panels	2	1 X 16 Sqmm YY Cable
12	HV Motors(6.6kV & 11kV)	2	1 X 120 Sqmm YY Cable
13	Low Voltage Motors		
13.1	Motor upto 7.5kW	2	1 X 6 Sqmm YY Cable
13.2	9.3Kw to 22kW	2	1 X 16 Sqmm YY

Sr. No	Particulars	No.of Earthing Points (Minimum)	Earthing Conductor Size & Specification
			Cable
13.4	30Kw to 55kW	2	1 X 50 Sqmm YY Cable
13.5	Above 55kW	2	1 X 120 Sqmm YY Cable
14	Local Control Station	1	1 X 6 Sqmm YY Cable

7.2.6 Electronic Earthing shall be considered for all Electrical Equipment inside Substation. It should run isolated from Electrical Network. Copper insulated cables shall be considered for this purpose. Support insulators shall be used while forming junctions for taking tap from main grid. The earth pits shall be colour coded to identify from Electrical Pits.

7.2.7 Value of earth resistance of an earthing system to be in general mass of earth shall be as follows.

a For electrical system and equipment , a value that ensures operation of the protective device in the electrical circuit but not exceeding 1Ohm.
b 5 Ohms for plant area
c For lightning protection value of resistance of 10 Ohm shall be maintained.
d Overall grid resistance *shall* be less than 1 Ohm.
e Number and location of earth pits in the plant shall be subject to PMC/Owner's approval

7.2.8 Under ground earthing strips shall be provided with 30% corrosion allowance.

7.2.9 Separate earth electrodes shall be considered doe numerical relays and electronic equipments as per manufacturer's recommendations.

7.2.10 Earthing system between the source i.e CPP substation and other substations shall be interconnected using single core PE conductor.

7.2.11 Above ground earthing shall be by copper conductor PVC insulated cable(green)

7.3 Lighting System

7.3.1 Plant lighting system shall comprise:
i) Normal lighting
ii) Emergency lighting
iii) Critical lighting

Normal and emergency lighting shall be fed by AC supply (415/240 V, three phase, four wire) while critical lighting shall be fed by 110 VDC supply.

7.3.2 Normal lighting system shall provide enough illumination so as to enable plant operator to move safely within the accessible areas of plant, to perform routine

operation including reading of field instruments, operation of all valves etc. and to carry out all the necessary maintenance and adjustment to equipment.

Areas requiring AC emergency lighting shall include but not be limited to the following:

- All areas requiring DC critical lighting
- Strategic locations in process, utility areas where specific safety/shutdown operation are to be carried out.

7.3.3 Generally, 25 % of the total lighting fixtures (except outdoor floodlights & streetlights) shall be fed from AC emergency supply. Also 25% of lighting of approach roads around control room. DG room shall be fed from AC emergency supply. Refer the detailed requirement of Emergency lights at different locations in Electrical Design Data Doc No: A-6261-098-002.

7.3.4 During normal operation both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency source after the starts of DG set. Critical (DC) lighting shall be normally kept "OFF' and during failure of AC power, battery bank shall feed the critical lighting system.

7.3.5 Lighting system shall consist of lighting transformers for reduction of fault level, lighting distribution boards(LDBs), lighting and power panels, fixtures, junction boxes etc.

7.3.6 All outdoor lighting shall be automatically controlled by means of synchronous timers / photocell with manual overriding control.

7.3.7 Telescopic tabular high masts 30 metre shall be provided for illumination of tank/ farm/ general area. The high masts shall be of continuously tapered polygonal cross section and fabricated out of steel plates. The masts shall be provided with motorized racking mechanism for lowering & hoisting lantern carriage. Each mast shall have internal power tool.

7.3.8 HPMV lamps shall generally be used for outdoor plant areas for normal plant lighting. Keeping in view the restrike time lag of HPMV Lamps and to avoid complete darkness in case of a voltage dip condition, necessary A.C. Emergency 160W MLL lamps shall be judiciously provided.

7.3.9 Fluorescent lamps shall be used for indoor lighting, for non-process buildings and control room.

7.3.10 Safe area flood light and street lighting shall have mercury vapour lamps.

7.3.11 All chemical handling facilities shall be provided with chemical resistant fixtures.

7.3.12 DC critical lighting shall employ incandescent lamps.

7.3.13 Low pressure sodium vapour lamp shall not be installed in hazardous area

7.3.14 Tall structure shall have aviation obstruction lighting as per statutory requirements.

7.3.15 Lighting system shall be designed based on minimum illumination levels as specified below:

Area	Illumination level in LUX
- Roads, approach trestle & Fence	10
- Pump houses	100
- Main operation platforms and access stairs	60
- Ordinary platforms	20
- General Process areas, pipe rack, Heat exchanger, cooling tower,separators	60
- Switchgear room	200
- Battery room	150
- Control room	300
- Stairs	100
- Transformer bay / cellar	100
- Pressurization & Air Conditioning room	150
- Warehouse	100
- Offices in non plant buildings	300
- Laboratory	300
- Workshop / Machine Shop	200
- Admin Building ,General area	100
- Building Entries	30
- Mechanical Equipment and Service Area	50
- Loading Platforms	150
- Toilet, Locker Room	50
- Compressor area	150
- Storage Buildings	50

Lighting design shall conform to relevant IS Codes & Standards and shall take into consideration, the requirements from point of view of safety and ease in operation and maintenance. A maintenance factor of 0.7 shall be assumed for lighting illumination level calculations for normal areas. However, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.

7.3.16 Wiring for lighting and convenience outlets in outdoor areas and plant buildings shall be carried out with copper conductor, PVC insulated, armoured and PVC sheathed, FRLS cables run along the column/platforms and structures. The armoured cable shall enter lighting fixture/JB through double compression gland through flameproof glands suitable for area classification. Suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard).

7.3.17 For building with false ceiling, concealed conduit wiring shall be used below the false ceiling and surface conduit wiring above the false ceiling.

7.3.18 Heavy duty PVC conduits shall be provided for concealed conduit.

7.3.19 Adequate number of ceiling fans points shall be provided in Offices, rooms allocated for operating and maintenance personnel etc

7.3.20 Battery room shall have fixtures mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room

7.3.21 Locally mounted lighting fixtures on platforms, walkways, and stairs shall be mounted in such a way that maintenance can be done without use of ladders.

7.3.22 Individual 30mA RCB's / ELCB's shall be provided for the outgoing three phases(R-Y-B) with the main panel incomer as 100 / 300mA RCB / ELCB.

7.3.23 A minimum of 25% spare MCB outgoing feeders shall be left as spare in all lighting & Power Panels.

7.3.24 Adequate numbers of 5A/15A,3 Pin sockets shall be provided in all the buildings.

7.3.25 The flameproof lighting and power panels shall conform to spec.6261- N-192D

7.3.26 The lighting fixtures for hazardous locations shall conform to Spec. 6261- N-191B

7.3.27 Lighting work shall be done as per Specs.6261- N-301 and cl.9.0 of Electrical design data.

7.3.25 For all lighting and power panels in hazardous areas, incomers shall be provided with 4 pole MCBs and outgoings shall be with DP MCBs + ELCBs.

7.3.26 Lighting fittings shall be energy efficient type and all ballasts shall be provided with capacitors for power factor improvement (to 0.95).

7.3.27 Twin neon (40W) flashing lamps, maintenance free aviation lighitng for all tall structure, stacks, reactors,etc. as per aviation regulations and norms shall be provided. Aviation lighting fixtures shall be fed from the emergency lighting panel only. Aviation lighting fixtures at each elevation shall be fed from different circuit to ensure availability of aviation lighting in case of one circuit failure.

7.3.28 All lighting fixture shall also have independent earth terminal outside the enclosure.

7.3.29 Flame proof and weather proof panel (IP-55) shall be standardized to have 6, 12 and 18 ways.

7.3.30 MCBs provided for outgoing feeders shall be rated for 16A/10A and shall have overload and short circuit releases. MCBs shall have ON/OFF mechanical indication.

7.3.31 Location of the high mast lighting shall be decided to avoid fouling / overlapping of existing nearby high mast lighting system if any.

7.3.32 Adequate number of pull boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these pull boxes

8.0 EQUIPMENT INSTALLATION, FIELD TESTING AND COMMISSIONING

8.1 Equipment installation, field testing & commissioning procedure shall be done as per specs. 6261-N-301 and 6261-N-303

8.2 Detailed installation, field-testing & Commissioning procedure shall be developed by LSTK CONTRACTOR and submitted for review/approval of OWNER/Consultant's engineer-in-charge at site.

8.3 The equipments shall be put in service after completion of testing & commissioning to the satisfaction of Owner's/Consultant's Engineer in-charge at site.

9.0 SPECIFIC REQUIREMENTS

9.1 FRP Canopy shall be provided for all outdoor equipment.

9.2 For 4-20mA signal interface between switchboards and DCS, Screened cables shall be used.

9.3 The junction boxes /telephone tag boxes shall be of GI sheet steel for safe area or die cast AL alloy construction with IP-55 protection suitable for installation in classified hazardous area.

9.4 The Junction boxes shall be suitable for terminating or looping armoured cables.JBs shall be provided with earthing stud and shall be earthed. They shall be suitable for Wall/Column mounting .

9.5 Colour of the outer sheath of the telephone, plant communication and fire alarm cables shall be blue, grey and red respectively.

10.0 MAKE OF EQUIPMENT / COMPONENT

CONTRACTOR shall restrict the make of major equipment to the makes as indicated in the vendor list.

ITEM	MAKES
Auxiliary Relays	ABB, Alstom, Jyoti.
Heavy duty Switches	Controls and Switchgear, Indo Asian Fuse gear, L & T, Schneider Electric, Siemens.
Fuse Switch combination Unit	ABB, Controls and Switchgear, Indo Asian Fuse gear, L & T, Schneider Electric, Siemens.
Fuses	GE Power Control, Indo Asian Fuse gear, L & T, Siemens.
Contactors	ABB, Bhartia Industries, GE Power Control, L & T, Siemens, Schneider Electric, Control and switchgear.
Instrument Transformer (CT/PT). MV	Gilbert and Maxwell Electrical, Jyoti, Kappa Electrical, L & T, Narayan Power tech, Pragati Electrical, Precise Electrical, Control and switchgear.
Instrument Transformer (CT/PT). HV	ABB, Electrical Controls and Systems, Jyoti, Kappa Electrical, Pragati Electrical. Alstom
Timers	Bhartia Industries, Concord Controls, Electronic Automation, L & T, Siemens.
Bimetal Relays	ABB, Bhartia Industries, L & T, Schneider Electric, Control and switchgear, Siemens
Control Switches (breaker)	Alstom, Reliable Electronic Components (RECOM), Switron Devices.
Control Switches / Selector Switches	Alstom, Havell's India, Jyoti, L & T, Siemens, Switron Devices. Hotline switchgear
MCCBs	GE Power Control, L & T, Schneider Electric.
Meters	Alstom, Automatic Electric, IMP Power, MECO Instruments, Rishab
Push buttons and Indicating Lamps	Bhartia Industries, Concord Controls, L & T, Control and switchgear. Siemens, Shri Tulsi Switchgears, Teknic Controls, Vaishno Electricals. Hotline switchgear
MCBs	Datar Switchgear, Havell's India, Indo Asian Fusegear, Indiana Current Control, Legrand India, Standard Electricals,
Earth Leakage Circuit Breaker	Datar Switchgear, Indo Asian Fusegear, Legrand India
Buchholz Relay	Atvus Industries, A J Services.
Magnetic oil level gauge	Instrument and Controls, Sukrut Udyog.
Oil Temperature Indicator	Precimeasure, Perfect Controls.
Winding Temperature Indicator	Precimeasure, Perfect Controls