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Category Codes (Submission Purpose)

- ☐ 1 For Approval
- ☐ 2 For Review / Comments
- ☐ 3 For Information
- ☐ 4 For Engineering
- ☐ 5 For Enquiry
- ☐ 6 For Order Placement
- ☐ 7 Final & Approved
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Acceptance Codes (Approval Codes)

- ☐ 1 Approved
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Remarks for AC2 : This marked-up drawings is hereby approved for fabrication / manufacturing and shall be re-sbumitted after revision. This drawing should be revised only to the extent of tkIS India / Owner / Client comments. Any other changes made by you will not be considered unless clearly highlighted in covering letter asking for approval.

This approval / review does not absolve the supplier from the full responsibility for design and fabrication.

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Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC
02		Finalized After NALCO'S Review And Issued For Engineering	22.03.18	PDW	22.03.18	MSD	22.03.18	for RPM	
01		Finalized After NALCO'S Review And Issued For Engineering	19.01.18	PDW	19.01.18	MSD	19.01.18	RPM	
00		ISSUED FOR ENGINEERING	16.11.17	PDW	16.11.17	RPM	16.11.17	RPM	-

Barcode

Category Code: 4

INDEX SHEET

The document Cover Sheet indicates revisions made in this document along with the purpose of issue of the revised document. The details of revisions made in the enclosures of this document are listed in the table of *Contents* below and the enclosures listed therein are an integral part of this document.

CONTENTS

1.0 SCOPE

These guidelines shall be read and construed along with all other documents, for example General Engineering Specification, Single Line Diagram, Technical Specifications for various electrical equipment and Battery limit & Interfaces – Electrical.

All the documents in the tender form the minimum basis for the complete design of the electrical system for developing a comprehensive and proper engineering / implementation of the Electrical facilities. Site conditions defined in the tender shall be taken into consideration.

CODES AND STANDARDS

a. The design and the installation shall be in accordance with established codes, Standards, technical specifications, sound engineering practices and shall conform to the statutory regulations applicable in India and at Site Location.

b. The latest version of main codes, standards and statutory regulations given below shall be considered as minimum requirements.

1. Codes and standards:
   - Indian standards (IS)
   - International standards (IEC)
2. Statutory regulations:
   - Indian Electricity Act
   - CEA regulations
   - The Factories Act
   - State Pollution Control Board, Odisha
   - Requirements of other statutory bodies as applicable, e.g. State Electrical Inspectorate, CCE, DGMS, ICAO.

c. For equipment procured in India, Indian standards (IS) shall be referred whereas for equipment that is procured outside India, the relevant and applicable IEC standard shall be followed.

2.0 SITE CONDITIONS

Site conditions shall be as per the document Design Basis attached elsewhere in the tender.

Design ambient temperature for all electrical equipment shall be 50 deg. C.

All electrical equipment shall be suitable for the specified site conditions even if they are installed indoors inside Air-Conditioned / ventilated rooms.

3.0 SYSTEM DESIGN PHILOSOPHY

3.1 GENERAL

The electrical system shall be designed to provide the following:

- Safety to personnel and equipment both during 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.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Suitability for applicable environmental factors.
- Fail safe feature
- Maximum interchangeability of equipment
- Freedom from Environmental concerns and health hazards.

3.2 POWER SYSTEM DESIGN

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

2 Load segregation in a substation shall be done keeping in view the aspects like: Type: Criticality (agitator, sump pump), Application (area of use), Redundancy, ease in availability of shutdown & optimization of shed-able load. Based on the consumer list during detail engineering, load segregation shall be done in consultation with OWNER/ Consultant. Accordingly the no. of transformers and switchgears shall be decided during detail engineering.

3.3 CAPACITY OF ELECTRICAL SYSTEM

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 process unit shall be calculated for its operation at the design capacity. System design shall permit direct-on-line starting of all motors unless otherwise specified or agreed.

3.4 SYSTEM VOLTAGES

System voltages shall be as defined in General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002) and Single Line Diagram (Doc. No. 6695-ELT-G00-FA-0001).

3.5 SYSTEM EARTHING

System earthing for incoming supply and primary / secondary distribution system shall be as per General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002). The 11 kV and 6.6 kV systems neutral shall be resistance grounded. The 690V, 415 V & 380 V systems neutral shall be solidly earthed.

3.6 SHORT CIRCUIT CAPACITIES

Each short circuit interrupting device shall be designed to have rated service short circuit breaking capacity (I_{CS}) equal to or higher than the maximum value of short circuit current calculated, at its location. The related switchgear, bus-ducts and associated components shall be rated for standard short circuit values above maximum available fault current for a minimum period as specified in GES/ SLD.

Maximum and minimum short circuit MVA values to be considered at battery limit (11 kV) for design of electrical system shall be 762 MVA and 350 MVA respectively

3.7 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. Lightning arresters and surge arresters shall be provided where necessary.

3.8 PROTECTION AND METERING SCHEMES

a. The protective system shall be selected and coordinated to ensure the following:

- Protection of equipment against damage, which can occur due to internal or external short circuits or atmospheric discharges.
- Uninterrupted operation of those parts of the system, which are not affected by the fault.
- Personnel and plant safety.

b. Protection relays shall be provided as specified in General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002) and Single Line Diagram (Doc. No. 6695-ELT-G00-FA-0001). In general, quick acting relays (with time delays, if necessary) shall be used and all fault tripping shall be done through separate hand reset type high speed tripping relays (e.g.: VAJH or equivalent).

c. Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified in General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002).

3.9 DC POWER SUPPLY

Independent DC power supply systems shall be provided for the Electrical switchgear controls and for critical lighting.

Each DC power supply system shall include charger-cum-rectifier, batteries and DC distribution board. Battery backup time shall be as specified in General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002).

3.10 EMERGENCY POWER SUPPLY

2

The emergency power supply system, wherever envisaged, shall feed the following: Electrical loads essential for the safe shutdown of the plant, Emergency lighting, agitators, sump pumps, HVAC, Exhaust fans (two or more) in substation, Process plant instruments as required, Communication equipment, Fire detection and alarm systems, DC Supply systems, UPS Systems, Firefighting equipment excluding main fire water pump, Loads critical for process, plant and personnel safety. Emergency power supply could be from a different power source or Emergency Generator as per General Engineering Specifications – Electrical

(Doc. No. 6695-ELT-G00-EC-0002). Where Emergency Generator is envisaged, DG set shall be designed such that time for voltage built-up after start command shall be max. 10seconds.

The emergency generator shall, generally, not be required to run continuously in parallel with the normal power supply system. However, short time paralleling facility shall be provided for transferring load to normal power supply or other operational needs as required.

3.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

Uninterruptible power supply system shall be provided (as required), for meeting critical loads that cannot withstand a momentary interruption in voltage (e.g. critical instrumentation, control etc.). Double battery bank with battery sharing feature shall be provided for UPS system. Battery backup time shall be as specified in General Engineering Specifications – Electrical (Doc. No. 6695-ELT-G00-EC-0002).

One set of UPS shall be considered for Instrumentation loads and one set of UPS shall be considered for Telephone, PA, FA, SCADA, VFDs, transducer panel and other critical load.

4.0 EQUIPMENT DESIGN PHILOSOPHY

1. GENERAL

The equipment shall in general conform to Project specifications. Equipment shall be selected and sized as per philosophy given below:

2. TRANSFORMERS

4.2.1 Distribution Transformer

a. Transformers shall be three phase, oil immersed, double wound type suitable for locating inside building with grilled rolling shutters, unless otherwise specified. Transformers shall be of low loss type. Usually no-load and load losses shall be optimized for operation at around 40 – 50 % of their ONAN rating.

b. In general kVA rating and percentage impedance of each transformer shall be selected to limit the rated current and short circuit current to values which are within the current rating and interrupting capacity of switchgear available.

c. Transformer with secondary voltage of 433V shall be limited to 2500 kVA. Depending on the total load requirement, number of transformers and PCC shall be decided.

d. The kVA rating shall be decided on the following basis and should be a standard value:

- Sum of all operating loads (absorbed power) considered and largest standby Motor

- Intermittent load (30% of absorbed power).
- 20% margin for future load growth.

e. 100% standby transformers shall be provided in all units, offsite and utility substations, unless otherwise specified.

f. 11/6.6 KV transformers- Individual transformer shall be rated to feed the entire load of switchboard considering a load PF of 0.8 & transformer loading not beyond 80% of its capacity.

4.2.2 Lighting Transformer

a. Transformers shall be dry type, Vacuum Pressure Impregnated (VPI) unless otherwise specified.

b. Dry type transformer for lighting shall be suitable for non-linear load.

c. Sizing calculation shall include 50% margin for future load growth.

d. Transformer shall be suitable for harmonic loading due to LED light fixtures.

3. SWITCHGEAR

4.3.1 High Voltage Switchgear (11 kV, 6.6 kV, 690 V)

a. All switchgear and associated equipment/ components (Bus duct, Cables, Main Bus of switchboard), fed from transformers shall have rating at least equal to 110% of the rating of respective transformer feeding the same, under any circuit configuration.

b. Bus tie circuit breakers shall be same rating as the incomer.

c. Forced Air Cooled Circuit Breakers are not acceptable. Circuit breaker shall be de-rated for design ambient temp. and In-panel installation. Nominal rating of circuit breaker shall be selected accordingly.

d. All other switchgears not directly fed from transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 20% future load growth. Maximum demand shall be calculated similar to distribution transformer sizing calculation.

e. Spare outgoing feeders shall be provided in all switchgears, as per GES.

f. In case of HV vacuum circuit breaker or vacuum contactor, surge suppressors shall be provided for outgoing motor feeders, as a minimum.

g. Logic and Safety interlocks shall be hard wired and shall be provided as required.

h. Auto/ Manual Changeover schemes shall be hard wired. For typical scheme refer switchgear specification.

i. Switchboard shall be provided with Auto/ Manual/ Independent Mode.

j. Auto-change over shall be provided between incomers and bus coupler. Additionally manual change over through synchro check relay with momentary paralleling shall also be provided. All necessary hardware shall be included to achieve auto, independent and manual operation of incomers and bus coupler.

- **AUTO CHANGEOVER:**

i. Normally Bus-coupler is open and Incomers are closed.

ii. In case of sustained under voltage on one of the incomers, the associated incomer circuit breaker shall open provided the other incomer/ Bus supply voltage is healthy.

iii. After opening of incomer circuit breaker, bus-coupler circuit breaker shall be automatically closed after short time delay. Under voltage (20%) interlock shall be provided to ensure, dead bus closing.

iv. Auto changeover shall be blocked, if incomer circuit breaker trips on downstream fault. However trip due to restricted earth fault should not block the auto changeover.

v. Tripping of incomer on under voltage shall be blocked, if both the incomers simultaneously experience an under voltage, i.e. the incomers shall not trip in case of total mains power failure.

k. Manual Changeover schemes shall be provided to take out or take in service of healthy incomer. Example as below:

- **MANUAL CHANGEOVER**

i. Incomer no. 1 and 2 breakers are 'ON'. Bus-coupler breaker is 'OFF'.

ii. Incomer no.1 is to be taken out of service. Auto/ Manual/ Independent switch is set for Manual mode. Trip selector switch is set to trip Incomer no. 1.

iii. Close Bus-coupler breaker manually (interlocked with check synchronizing relay).

iv. Both the Incomers are momentary paralleled. After a set time delay Incomer no. 1 breaker shall open.

v. In case Incomer no. 1 does not open (and the two sources remain parallel more than the pre-set time) the last circuit breaker which was closed (Bus-coupler circuit breaker) shall open automatically.

vi. The two sources shall not remain parallel continuously.

l. Independent Mode shall be provided to operate Incomer and Bus-coupler breaker independently. All safety and logic interlock shall be provided (hard wired) to ensure safe operation. Only two breakers can be closed at a given time.

m. In general all circuits shall be wired for fail safe conditions.

n. Only major relays, meters and controls are indicated in the GES / SLD. Any auxiliary relays, timers, switches, etc., as required while developing the control schematic and felt necessary for safe operation, even if these are not specifically indicated, shall be supplied by the Contractor. All relays, metering and control components shall be mounted on the panel front only.

o. Where interface with PLC (for hardwired digital signals) is required, marshalling panel shall be provided at each bus section of the Switchboard.

p. Dummy panel and rear extension shall be provided, as required, for bus trunking / cable terminations.

q. Numerical relays shall be used for protection function only. Control function shall not be integrated into the relays. Control logic shall be achieved through hardwired auxiliary relays, timers, etc.

r. All numerical relays shall be integrated to substation RTU and substation automation system for monitoring and control on IEC 61850 protocol.

s. All composite multifunction meters shall be integrated to substation RTU and substation automation system for monitoring and control on MODBUS.

t. Switchboard shall be rated for short circuit rating equal to or higher than the maximum specified/ calculated value of the short circuit current at the point of installation.

u. In case of 690 V switchgear, the outgoing MCCBs shall be provided with shunt trip.

v. In case of 11kV switchgears, transducers (with galvanic isolation) for current feedback (analog signal) to DCS shall be mounted in the respective outgoing motor feeder within the switchgear.

w. In case of 6.6kV switchgears, transducers (with galvanic isolation) for current feedback (analog signal) to DCS shall be mounted in a separate transducer panel located within the switchgear room in substation.

4.3.2 Low Voltage Switchgear (415 V PCC, MCC)

a. All switchgear and associated equipment/ components (Bus duct, Cables, Main Bus of switchboard), fed from transformers/ Generators shall have rating at least equal to 110% of the rating of respective transformer/ Generator feeding the same, under any circuit configuration.

b. In general bus tie circuit breakers shall be of same rating as the normal incomer rating.

c. Forced Air Cooled Circuit Breakers are not acceptable. Circuit breaker shall be de-rated for design ambient temp. and In-panel installation. Nominal rating of circuit breaker shall be selected accordingly.

d. All other switchgears not directly fed from transformers/ Generators shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 20% future load growth. Maximum demand shall be calculated similar to distribution transformer sizing calculation.

e. Spare outgoing feeders shall be provided in all switchgears, as per GES.

f. Two Incomer and One Bus-coupler PCC scheme shall be similar to HV switchgear.

g. Logic and Safety interlocks shall be hard wired and shall be provided as required.

h. Auto/ Manual Changeover schemes shall be hard wired. For typical scheme refer switchgear specification.

i. PCC shall be provided with Auto/ Manual/ Independent Mode.

j. Circuit breakers shall be of four pole type for incomers and bus-couplers in 415 V PCC & 415 V MCC including circuit breakers for generator incomer and the associated bus coupler.

k. LV switchboards shall be designed such that only one Air Circuit breaker feeder shall be accommodated in one vertical panel.

l. The maximum rating of bus-bars for MCCs/ ASBs/ LDBs should preferably be limited to 800 A. Heavy duty type load break switches/ ACB shall be used for incoming and tie breakers and these shall have suitable mechanical interlocks.

m. Each substation will have at least one PCC with 2 transformer incomers and one emergency power supply incomer from Owner's Emergency switchboard. Refer the Detailed SLD for operation philosophy of PCC with 2 transformer incomers and one emergency incomer.

n. In case of more no. of PCCs in a particular substation depending on the load requirement, other PCCs may have 2 nos. transformer incomers only, without any emergency incomer.

o. Circuit breakers/ contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors. The air break contactors shall have rating one size higher than that recommended by vendor's type 2 coordination chart.

p. Separate feeders shall be provided in the switchboard for each load/ motor. However, as an exception maximum three numbers welding receptacles may be connected to one power feeder.

q. In case of 415V switchgears, transducers (with galvanic isolation) for current feedback (analog signal) to DCS shall be mounted in a separate transducer panel located within the switchgear room in substation. One common transducer panel for all 415V switchgears shall be considered.

4. BUS DUCT

The continuous current and short circuit rating of bus ducts shall be least equal to the main bus bar to which they are connected.

5. NEUTRAL GROUNDING RESISTOR

The NGRs shall be rated to withstand the fault current for 10 seconds. The current rating shall be as specified in the GES.

6. BATTERIES

Batteries shall be of adequate capacity to meet the back-up requirements as envisaged in the duty cycle as well as to take care of future load growth as specified in GES. Battery sizing calculation shall be as per IEEE 485. Temperature correction factor and ageing factor shall be considered for sizing the battery. Battery end cell voltage shall be as per GES. Average discharge voltage shall be considered while calculating discharge current during the load cycle. Batteries shall be complete with battery racks and accessories.

7. BATTERY CHARGER AND DISTRIBUTION BOARD

a. The battery charger/ rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging/ initial charging of battery.

b. Each battery charger and DCDB shall be sized to cater to selected battery capacity.

c. DCDB shall be a separate panel.

d. Incoming power supplies to a DC system shall not be taken from the same primary generation/ distribution source. At least one source of supply shall be from the emergency bus of the PCC.

8. UNINTERRUPTIBLE POWER SUPPLY SYSTEM

a. UPS system shall be parallel redundant type and sized to take care of the crest factor of the load current.

b. Incoming power supplies to a UPS system shall not be taken from the same primary generation/ distribution source. At least two sources of the incoming supply shall be from the emergency bus of the PCC.

c. UPS shall be with double battery bank with common battery sharing feature.

d. UPS system shall include a set of storage batteries, rectifier transformer, rectifier-cum-charger, inverter, set of filter circuit, static switches, bypass transformer with SCVS, facility for manual transfer between inverter supply and bypass line, facility for bypassing inverter and static switch for maintenance, AC Distribution board and other associated accessories.

e. Under normal conditions, for a parallel redundant system, both UPS systems shall feed the load equally and charge the battery set. In case of failure of any of the systems, the healthy system shall feed the complete load without any interruption. If both UPS systems fail, then the load shall be transferred automatically to stabilized bypass supply. Normally, the inverter shall be operated in synchronised mode with the bypass line, and manual forward transfer or manual reverse transfer shall be effected without any break. Automatic forward transfer, in case of inverter malfunction shall be effected with a break not exceeding 4 milliseconds in synchronous mode and 20 milliseconds in asynchronous mode.

f. Each branch circuit of the UPS distribution system shall have a fused disconnect switch. The fuse shall be fast clearing type and the fuse rating shall be co-ordinated with the rating of the UPS system. Normally the largest branch circuit load shall not exceed 25 % of the UPS system rating.

9. MOTORS

a. In general, three phase squirrel cage induction motors designed for direct-on-line starting shall be used. Motors shall preferably be totally enclosed, fan cooled type and suitable for continuous outdoor use.

b. All motors shall be continuous maximum rated with the possible exception of crane and hoist motors, soot blowers, turbine/ engine starting motors etc. which may be rated for the envisaged duty cycle.

c. High and Low voltage motors shall be suitable for starting under specified load conditions with 80% and 75% of the rated voltage respectively at the terminals.

d. For heavy duty drives such as reciprocating compressor/ agitator/ crusher etc., high starting torque motors shall be provided, and starting time shall be limited to ensure adequate protection by motor protection relays.

e. Induced voltage across the shaft ends of motor shall not exceed 250 mV (rms) for ball and roller bearings and 400 mV (rms) for sleeve bearings. Wherever it exceeds the specified limit, the non-driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.

10. SCADA

a. Substation level networking of numerical relays and multifunction meters shall be done to achieve the following –

- Closing & tripping of all 11 kV breakers
- Status monitoring of 11 kV system
- Status monitoring of 6.6 kV switchboards & 6.6 kV motors
- Monitoring of all transformer troubles
- DG sets (RUN, TRIP status) and current, MVAr control (Tap changer & GenVar)
- 415 V switchboards & motors.
- VFD (Speed Indication, Fault Code, Motor Running feedback (either in VFD or Bypass Mode), Motor Trip (either in VFD or Bypass Mode), Read to start Feedback, VFD Temperature)
- Metering (I, kW, kWh) for all motors ≥ 30kW.
- Status monitoring of battery chargers & UPS

b. All the above shall be wired to substation RTU for alarm / annunciation at Centralised SCADA as per the Typical Interface I/O list. Also refer DCS architecture in instrumentation document.

2 c. Networking of relays, meters & hardwired I/Os as indicated in the Typical SCADA block diagram for Unit substation level networking (doc. No. 6695-ELT-G00-FA-0004) shall be followed.

d. Ethernet Switches shall have following features:

- Managed Ethernet Layer 2 switches with10/100 Mbps
- IEC 61850-3 compliant
- With Dual Redundant power supply
- Grade – Industrial, with fanless design suitable for design ambient temperature
- With Self diagnostic capacity
- Network Redundancy: PRP / HSR in accordance to IEC 62439

- Atleast two ports compatible for connection with LAPTOP
- LED indications for status and faults, voltage.
- Pass word protected access control
- No. of ports 8 / 16/ 24/ 48
- Spare ports in Ethernet switch:- 10 % for engineering + 20 % for Future
- Preferred Makes of Ethernet Switch - Garretcom, Hirschmann, Ruggedcom, Moxa

e. Protocol Converter shall have following features :

- Ethernet interface speed 10/100Mbps
- Required RJ45 Ethernet (TCP/IP) interface ports
- Required RS485 serial interface ports
- With Dual Redundant power supply
- LED indications for ready, status, fault.
- Pass word protected access control
- Preferred Makes of Protocol converter - Garretcom, Hirschmann, Ruggedcom, Moxa

11. VFD

a. VFD system shall be hardwired to plant DCS (analog signals) and to plant PLC (digital signals) for exchange / interlocking and monitoring at CCR & Operator terminal at Shift locations for each substation.

2 b. VFD system shall also have soft communication link (dual) on MODBUS (for Metering) IEC61850 (for protection) for interface with SCADA. This also includes VFD Parameterization from a single point at each substation.

c. Specification for Cables associated with VFDs shall be as per recommendation of VFD vendor.

d. VFD shall not be preferred for hoist applications.

12. CABLES AND WIRES

a. Special cables e.g. twisted pair or shielded control cables etc. shall be used as applicable for numerical relays, VFDs etc. to suit selected equipment as per equipment supplier's recommendations.

b. The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system earthing and short circuit withstand criteria as applicable. The derating due to ambient air

temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil, etc. shall be taken into account.

c. The sizing of high voltage cables shall also be based on the rated short circuit withstand capacity for a minimum time period as dictated by the protection system as defined in General Engineering Specifications - Electrical (Doc. No. 6695-ELT-G00-EC-0002), in addition to the maximum anticipated load current.

d. Cables connected in parallel shall be of the same type, cross-section and terminations.

e. All power and control cables shall be in continuous lengths (unless otherwise agreed upon) without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Unless otherwise agreed, cable joints shall not be permitted in hazardous areas.

f. Cable for transformer/ Generator shall be sized for 110% of the rated current and all incoming cables to switchgear/ UPS/ DC system/ DBs and other equipment shall be sized for 120% of the rated current.

g. Cable for capacitor banks shall be sized for 135 % of the rated capacitor current.

13. POWER FACTOR IMPROVEMENT CAPACITORS

a. 6.6 kV Capacitors for power factor improvement shall be sized for minimum 4 steps i.e. 25%, 50%, 75% & 100% load.

b. Sufficient no. of steps shall be selected based on plant operation at various operating and load conditions to maintain the targeted power factor; over voltage and over compensation shall be avoided.

c. Overall power factor to be achieved at 11 kV is 0.95 lag and Power factor to be obtained at 6.6 kV & 415 V should be in the range of 0.95 to 0.98.

d. Power factor improvement bank shall be detuned and shall be sufficiently sized so that harmonic loading shall not overload the bank.

e. HV capacitors & series reactor shall be placed in a separate room enclosed in RCC building. Capacitor control panel shall be placed in switchgear room.

f. Sufficient clearance shall be provided to avoid electro-magnetic and circulating current. Vendor recommendation shall be followed.

14. LOCAL CONTROL STATION

a. Each motor shall be provided with a control station in the field, unless otherwise agreed upon.

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

- Start/ Stop push buttons

- Ammeter
- Cable glands

c. Stop push button shall generally have stay put feature.

d. Load Break Switch shall be provided in field near each LV motor. This switch shall be housed in a weather proof enclosure and shall be provided with padlocking facility. Auxiliary contact shall be provided for interlocking with the Local control station.

e. Emergency Stop Push button shall be provided near oil filled transformer and HV Capacitors.

15. WELDING & CONVENIENCE RECEPTACLES

a. These shall have the necessary mechanical interlocks and earthing facilities. The enclosure shall have suitable protection for site conditions specified (flame proof, weather proof, dust proof, corrosion resistant, etc.).

b. Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 50 m length of trailing cable to any point in the process area. These shall be rated for 60 A suitable for 415 V, 3 phase system with a scraping earth.

c. Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 25 m length of cable to all manholes of process equipment and other important areas in the process units. These shall be rated for 20A, 240 V single phase with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. Hand lamps shall be rated for 24 V. Accordingly, Special sockets with in-built 240/ 24 V transformers/ hand lamps with in-built 240/ 24 V transformer shall be provided at locations wherever necessary to carry out inspections in vessels etc.

16. ACTUATORS FOR MOTOR OPERATED VALVE

MOVs shall be provided with integral starters. The necessary local/ remote selector switch, start/stop control switches or push buttons, torque limit switches etc. shall be provided on actuator for local/ remote control depending on the mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without damage. The control circuit may be AC operated for short distance and DC operated for extended distances, where required. MOVs with 2 wire control shall comply to job specifications and control supply shall be as specified therein.

17. FIELD EQUIPMENT

In many areas of the plant, equipment will be exposed to airborne caustic mist and splash. Preferred

materials of construction for parts exposed to the external atmosphere are polyester or epoxy, fibreglass, plastic, stainless steel. Materials susceptible to attack by caustic such as copper, aluminium, zinc and their alloys are not acceptable.

18. PLANT WIDE COMMUNICATION AND FIRE ALARM SYSTEM

4.18.1. PUBLIC ADDRESS SYSTEM

a. It shall consist of the following:

- Central exchange along with power supply system.
- Master station
- Desk type call stations along with microphone and external loudspeaker with built-in amplifier for installation in buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external loudspeaker with built-in amplifier as per Operational requirements.

b. Noise hood and flashing beacons shall be provided in High noise area.

c. Paging speakers shall be suitable for installation in areas having high ambient noise levels without compromising the audibility performance.

d. The construction of the exchange shall be designed to allow for at least 10% expansion for future additions without involving any major modifications in the system. The exchange shall be fully wired for connecting the future field call stations (if shown) in the speech diagrams.

e. Location of Public Address points shall be based on process input and approval of location shall be during detail Engineering.

4.18.2. FIRE DETECTION AND ALARM SYSTEM

a. The Fire Detection and Alarm System shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke and heat detectors, main panel, zonal panel, hooter, battery, battery charger and other hardware. The system shall be designed to provide audio-visual indication at the main panel to be located in control room and repeater panels, in fire station.

b. The system shall be designed and installed in accordance with NFPA, TAC & IS-2189 standards.

c. The manual call points shall be provided at strategic locations with access of 60 m along all exit routes and roads.

d. Electrical sirens shall be provided to cover entire plant area.

e. Hooters and exit lights shall be provided at required locations in the buildings.

f. Panel design and component selection shall be done for future extension up to 10% of specified zones or one zone, whichever is maximum in each panel. The design of common facility and hardware shall be provided for required future extension of zones.

g. The fire detection system shall be interfaced with fire suppression system wherever specified.

5.0 SUBSTATION/ MCC ROOM DESIGN PHILOSOPHY

a. The sub-stations shall be located close to the load center. Proper access shall be provided/ ensured for operation/ maintenance of indoor and outdoor equipment.

b. HV & LV 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 at least 450 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 5 m and shall house all busducts, cable trays and their supports. Transformer floor shall be at least 150 mm above the approach road level.

2 c. Cable Trench with removable cover shall be provided in the cable cellar for routing of cables from HV Switchgear to Transformer.

d. In addition to the entry to substation for operating personnel, a separate entry of clear size 3 m (W) x 3.5 m (H) with rolling shutter shall be provided for drawing in all equipment for installation. The Sub-station shall also have an emergency door opening outwards. The same shall be suitable for 2 hour fire rating.

e. Sub-station wall adjacent to the transformer bays and walls separating transformers shall have at least 4 hour fire rating.

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

g. UPS system, Battery & battery charger, Variable speed drive panels, telecommunication panels, SCADA panels shall be located in air-conditioned room along with associated VRLA batteries.

h. Sub-station shall have fire extinguishers, first aid boxes and other safety equipment as specified in the document “Contractor’s Scope of Work” and as per statutory requirements.

i. Insulation coat paint on the floor for both front & back side of Electrical panels shall be provided.

j. Equipment like transformers, neutral grounding resistors, reactors and HV capacitor banks 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.

k. The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance after considering space for future panels. The minimum clearances around various equipment shall be as specified in the document GES-Electrical.

l. Vertical clearance above the top of the 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 and top of any equipment.

m. In case of transformer bay, untanking height indicated in the transformer GA drawing shall be considered while deciding the roof height.

n. In all Substations/ MCC rooms, space for future extension of switchboards shall be provided as specified in the GES.

o. The DG sets shall be located in a separate building other 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, diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room.

p. Exhaust arrangement for DG set shall be as per Pollution Control Board norms.

q. Noise Hood shall be considered for DG sets as per Pollution Control Board norms.

r. Fire protection for Substation building (i.e. transformers and switchgear room, etc.) shall be provided to comply with requirements of IS, BIS, NBC.

s. Sub-station cable cellar shall have exhaust fans for ventilation which shall be backed up with fine wire mesh, to prevent vermin entry. Exhaust fans shall be fed from emergency bus of PCC in case of substations where DG emergency supply is available. In case of non-availability of DG emergency supply in any of the substations, the exhaust fans shall be powered by standalone single UPS (with bypass) with 2 hours battery back-up.

t. Windows provided in the substation shall be with fixed transparent pane.

u. The Emergency Stop Push Button (NO contact for tripping & NC contact for close permissive) with suitable water protection canopy shall be placed inside the Transformer yard with easy access from outside the yard gate.

v. Interference with piping ducts, HVAC ducts, false floor/ ceiling, equipment, man movement, equipment movement, equipment maintenance area etc. shall be taken into consideration in substation layout design.

w. Substation shall have Fire alarm devices such Fault isolator, Manual Call point, Multi-sensor smoke detector, Addressable hooter and Smoke detector with response indictor in false ceiling and false floor of substation room wherever indicated. Cable cellar and Transformer bay shall have Fire alarm devices such Fault isolator, Manual Call point, Multi-sensor smoke detector.

x. Direct buried cables (except bare earth conductors) shall be packed with screened fine sand, free from stone or chemically active material, to a finished thickness of at least 75 mm of packing on all sides.

y. All cables and cable ducts passing through walls and floors shall be sealed.

Sealing shall be suitable for:

- Filling of voids.
- Weatherproofing.
- Fire rating, (as required).
- Preventing migration of hazardous gas to non-hazardous areas (where applicable).

2 z. Fire proofing of cable entry into 11kV Switchgear panel shall be done. Fire retardant coating shall be applied on all cables in cable cellar.

aa. All unused holes shall be plugged properly in an approved manner as indicated by Engineer-In-Charge using metallic plug at top and bottom fastened by bolt and nut to make panel dust and vermin proof.

bb. In substation, Clear height for Cable Cellar shall be minimum 5000 mm, Clear height for False Floor & False ceiling shall be minimum 1200 mm and Clear height for Switchgear Room shall be minimum 4500 mm.

cc. Cable tray shall be provided for laying of cables in false floor.

dd. In each substation suitable signs shall be provided in conspicuous locations to advise and warn personnel, and shall include the following:

- Plant Equipment Tag Number and description.
- Danger signs relating to High Voltage.
- Exit signs.
- Resuscitation procedure for persons suffering from electric shock.
- Directions in case of fire.
- Emergency telephone numbers.
- Single line electrical diagram for the substation.

6.0 RELAY CO-ORDINATION

a. Following Coordination Time Interval (CTI) table shall be achieved for protection grading. Please note that CTI is measured between relay characteristic curves at the lesser value of either instantaneous pickup settings of the downstream device and the maximum fault current level that can be seen simultaneously by both the relays.

CTI VALUES (time in milliseconds)

DOWNSTREAM PROTECTION DEVICE	UPSTREAM PROTECTION DEVICE			
	FUSE	ACB RELEASE	EM RELAY	NUMERICAL RELAY
FUSE	CS	CS	220	120
ACB RELEASE	CS	CS	220	120
EM RELAY	200	200	300	250
NUMERICAL RELAY	220	220	250	200

7.0 SPECIAL INSTRUCTION:

2

1. Cables in tankage areas shall be laid at a higher elevation over the respective tanks to prevent damage due to regular exposure to steam.

ANNEXURE-I
Switchgear - DCS PLC Interface

Type of Motor Feeder	Potential Free contacts to PLC Hardwired		Potential Free contacts from PLC Hardwired		Analogue I/P from DCS Hardwired	Analogue O/P to DCS Hardwired
		Contact Operation		Contact Operation		
LV DOL FEEDER 2	ON TRIP (86) READY TO START	Close - "ON" Close - "Tripped on fault" (Close - "Ready to start")	PLC "On" PLC "Trip" Local/Remote Selection	Pulse type, Close - "ON" Latched type, Open - "Stop/Trip" Latched type, Close - "Remote Selected"		Current feedback (Y Phase) (4-20mA) - Transducer in separate panel For Motor ratings ≥ 15 kW & all Agitator Motor feeders
LV VFD FEEDER	ON TRIP READY TO START	Close - "ON" Close - "Tripped on fault" (Close - "Ready to start")	PLC "On" PLC "Trip" Local/Remote Selection	Pulse type, Close - "ON" Latched type, Open - "Stop/Trip" Latched type, Close - "Remote Selected"	Speed Reference (4-20mA)	Current feedback (Y Phase) (4-20mA) - Transducer in VFD Panel Speed feedback
HV DOL FEEDER With Vacuum Contactor (for < 1000 kW , 6.6kV Motor)	ON TRIP (86) READY TO START Trip supervision Relay (95)	Close - "ON" Close - "Tripped on fault" (Close - "Ready to start") (Close - "Healthy")	PLC "Start" PLC "Trip" Local/Remote Selection	Pulse type, Close - "Start" Latched type, Close - "Stop/Trip" Latched type, Close - "Remote Selected"		Current feedback (Y Phase) (4-20mA) - Transducers in separate panel
HV DOL FEEDER With Vacuum Circuit Breaker (for ≥ 1000 kW , 11kV Motor) 2	ON TRIP (86) READY TO START Trip supervision Relay (95)	Close - "ON" Close - "Tripped on fault" (Close - "Ready to start") (Close - "Healthy")	PLC "Start" PLC "Trip" Local/Remote Selection	Pulse type, Close - "Start" Latched type, Close - "Stop/Trip" Latched type, Close - "Remote Selected"		Current feedback (Y Phase) (4-20mA) - Transducers in 11kV Switchgear
HV VFD FEEDER (For > 200kW ≤630kW, 690V) (For > 630kW <1000kW, 6.6kV) (For 1000kW and above, 11kV) 2	ON TRIP READY TO START	Close - "ON" Close - "Tripped on fault" (Close - "Ready to start")	PLC "Start" PLC "Trip" Local/Remote Selection	Pulse type, Close - "Start" Latched type, Close - "Stop/Trip" Latched type, Close - "Remote Selected"	Speed Reference (4-20mA)	Current feedback (Y Phase) (4-20mA) - Transducers in VFD Panel Speed feedback