



VOLUME - II, PART - 2

SECTION – 3

DETAILED TECHNICAL SPECIFICATION - ELECTRICAL



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A. LOW VOLTAGE SWITCHGEAR

1.0 INTENT OF SPECIFICATION

This section covers the technical requirements of low-voltage switchgear.

The general terms and conditions, Instructions to Bidders and other attachments referred to elsewhere be hereby made part of the Technical Specification. The Bidder would be responsible for and governed by all requirements stipulated hereinafter.

Deviations if any should be brought out very clearly on the deviation sheet enclosed with this document only. Otherwise, it will be presumed that the Bidders offer is in line with what has been stated / asked for in this specification.

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be under the applicable section of the latest version of the relevant IS/IEC standards, CEA regulations etc. including amendments, if any, except where modified and/or supplemented by this specification. Some of the applicable standards are listed below:

- a) IS 10118 Code of practice for selection, installation and maintenance of switchgear and control gear.
- b) IS/IEC 60715 Dimensions of low-voltage switchgear and control gear - standardized mounting on rails of mechanical support of electrical devices in switchgear and control gear installations
- c) IS 12021 Specification for control transformers for switchgear and control gear for voltages not exceeding 1000V
- d) IS 13032 Miniature circuit breaker boards for voltages not exceeding 1000V
- e) IS 694 Specification for PVC insulated cables for working voltage up to and including 1100V
- f) IS 5 Colors for ready mixed paints and enamels
- g) IS 2705 Specification for current transformers
- h) IS 11353 Guide for uniform system of marking and identification of conductors and apparatus terminals
- i) IS/IEC 60529 Degrees of protection provided by enclosures (IP code)



- j) IEC 61439-1 General rules
- k) IEC 61439-2 Power switchgear and control gear assemblies
- l) IEC 61439-3 Distribution boards
- m) IEC 61439-4 Assemblies for construction sites
- n) IEC 61439-5 Assemblies for power distribution
- o) IEC 61439-6 Bus trunking system
- p) IEC 60947 Low voltage switchgear and control gear
- q) IEC 60529 Degrees of protection provided by enclosures (IP Code)
- r) IEC/TR 61641 Enclosed low-voltage switchgear and control gear assemblies – Guide for testing under conditions of arcing due to internal fault
- s) Indian Electricity Act and rules framed there-under
- t) Regulations laid down by the office of the Chief Electrical Inspector to the Government
- u) Regulations laid down by CEA/ CERC/BEE/CBIP of India
- v) National Electrical Code
- w) CEA (Technical Standards for construction of Electrical Plants and Electrical Lines) Regulation, 2022
- x) CEA (safety requirements for construction, operation and maintenance of Electrical Plants and Electrical Lines) Regulations, 2011
- y) Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023 Dated 16-06-2023.
- z) CEA (Installation and Operation of Meters) Regulations 2006
- aa) Indian Electricity Grid Code Regulation, 2023

3.0 BASIC SCOPE OF SUPPLY

3.1 Scope of Supply

- a) The scope of supply shall cover design, engineering, manufacturing, assembly, testing at manufacturer's works, and forwarding on FOB (Port Mumbai or Mundra) in case of supply from India or DDP at Project Site in case of supplies from any other country, Transportation to site is in the scope of Bidder. Erection testing and commissioning at site for the following:
 - 1. 415V Power Control Centers, Motor Control Centers, Distribution Boards, Local starters and Local Push Button Stations.
 - 2. LT Motors



3. Electric actuators
4. Panels and Soft Starters
5. 2x100% 230V AC UPS, 2x100% Ni-cd Battery, 60minutes back-up time, charger, Battery Health Monitoring system & Redundant ACDB
6. LT Power cables and control cables
7. Cabling system completes with GS cable trays, GS supports, conduits, glands, lugs etc. for all the cables of Desalination system including pump house & Borewell motors.
8. Above ground and below ground earthing of all the buildings, structures & electrical equipment / systems with maintenance free chemical earth pits shall be in Bidder's scope.
9. Electronic earthing system with maintenance free chemical earth pits
10. Lightning protection system with maintenance free chemical earth pits for all the buildings, structures and equipment.
11. Safety equipment's such as Electrical Insulating mats, first aid box, Danger plate, Sand buckets Firefighting and sealing system, PPEs etc. as per statutory requirements, etc.
12. Engineering of complete Electrical system including preparation of required sizing calculations, layouts, scheme diagrams, cable schedules, Interconnection schedules, relay setting calculation, QAP, MQA, FAT, SAT etc.
13. Basic engineering of complete Electrical system including Electrical load list, LV Switchgear, 415 V MCC, LT/ Control cables etc. cable sizing calculation, Cable schedule, cable layout & Interconnection diagram shall be provided for all the cables of Desalination plant including pump house and Borewell motors system.
14. Special tools & tackles, if any, required for maintenance of equipment. shall be provided by the Bidder.
15. First fill of consumables.
16. Illumination system for complete package
17. Spare parts required for successful commissioning
18. Mandatory spares
19. Any other electrical equipment and accessories required to complete the system

3.2 Scope of Services

Scope of Services shall include the following:

- Preparation and submission of drawings and documents in soft (Soft copy of excel file including but not limited to AutoCAD file) and hard form as per the drawings / document's submission schedule



- Submission of progress report
- Training of GIPCL personnel in operation and maintenance
- Erection, testing and commissioning shall be done by the successful Bidder. **TERMINAL POINTS**
- All MCC / distribution boards incoming & outgoing feeders with facility for cable connection (bottom entry).
- 220V DC Control supply at respective switchboard (From DCDB at PSS-1).
- Earth Terminals at respective switchboards.
- Fiber optic ports for communication of LV system at DCS panels.
- Any other supply item, erection or testing required for the plant is deemed to be considered in the scope of this contract even if not specifically mentioned in this specification

4.0 EXCLUSIONS

- Nil

5.0 TECHNICAL REQUIREMENTS

5.1 Low Voltage AC Switchgear

5.2 Separation of Cubicles

Floor mounted, Free standing, single/double front, compartmentalized Switchgear shall be provided. The individual switchgear cubicles shall be fixed type and isolated from one another by sheet metal material.

Inside the switchgear cubicles, the following compartments shall be isolated from one another by sheet metal material:

- Switchgear unit from cable connection compartment
- Busbar compartment from Switchgear compartment
- Cable connection compartment from busbar compartment

Segregation between the various compartments shall be made by earthed sheet steel barriers or approved synthetic material to prevent faults in one compartment from spreading



to an adjacent compartment. Sheet Steel thickness shall be min. 2.5 mm for load bearing and min. 2.0mm for other.

In case of bus section switchgear cubicles, Section A busbars shall be segregated from Section B busbars and from the circuit breaker compartment.

In the event of arcing, it shall not be possible for hot gases to escape to the front of the cubicle (the operational side).

The base of the switchgear panels shall be sealed with fireproof closures to seal the all cables.

5.3 Switchgear Components

The switchgear installations shall comprise at least:

- Steel-clad switchgear cubicles (with sheet steel thickness of minimum 2 mm) each separated from the other by sheet steel and with various components separated from one another and sufficient space for ease of O&M, repair & replacement.
- Different zones of individual boards shall be fully insulated from each other

All switchboards shall be provided with three phase and neutral high-quality tinned copper busbars. Entire busbar system shall be insulated with colour coated PVC sleeves. Busbar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.

The cross-section of the busbars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars

All busbars shall be adequately supported by non-hygroscopic, non-combustible, track resistant and high strength sheet molded compound or equivalent type polyester fiberglass molded insulator with creepage distance of 31mm/kV. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The busbar insulators shall be supported on the main structure

- Busbar Earthing studs including earthing fittings.
- Cable paralleling arrangements with auxiliary busbar systems, connecting bars for all in feeds and outgoing feeds which require more than two parallel cables.



- Fireproof enclosures to the base of the switchgear panels for sealing all the cables.
- Thermostatically controlled space heater(s) of SS 304 grade material with DP MCB for Heating systems, lightings & 5/15A sockets etc. within the switchgear panels.
- Padlocking arrangement as required.

All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. Replacement /Maintenance of individual equipment/component shall be possible without switching off or isolating the other equipment / components.

Prominent, engraved identification plates shall be of 3-ply Lamicoid, with white engraved lettering on black background. Inscription & lettering sizes shall be subject to Owner's approval.

Painting for interior shall be glossy white & for exterior it shall be RAL 7035 of IS: 5 and painting process as per C5-M standard specifications for outdoor and indoor application. Unless noted otherwise, all steel structures exposed to environment would be painted to meet the requirements of corrosion category or would be galvanized to minimum 110microns.

Switchgear Design shall be as per Seismic Zone - V of IS 1893

At least 20% (minimum 1 no) of the allocated cabinet units of each type and rating complete in all respect ready to use shall be provided as reserve cubicles for each main switchgear and distribution.

5.4 Soft Starters

The soft starter shall be designed for reduced voltage starting and controlled acceleration of three-phase induction motors.

It shall be capable of handling motor loads with high inertia, pumps, compressors, and conveyors.

Starting Mode shall be Current limit start, voltage ramp start, torque control.

Stopping Mode shall be Soft stop with adjustable ramp-down time.

It shall be equipped with following protections.



- Overcurrent and overload protection
- Phase loss / phase imbalance detection
- Short-circuit protection (through circuit breaker)
- Under-voltage and over-voltage protection
- Stall detection and jam protection

5.5 Local Indications

Each 415V plug-in unit (for ACBs) shall be equipped with individual signal lamps or position indicators which show the following switching conditions locally for ON OFF TRIP

The following minimum signals shall be additionally provided in the infeed panels of the main switchgear:

- No control voltage 220V DC (main ring)
- Lamp test facility
- Voltmeters to read the individual infeed voltage of the control supply.

Current for each Phases for each outgoing motor feeders and Multifunction cum Energy meter (0.2s class meter with 0.2s class CT and 0.2 PT if required) for incomings, Bus coupler, interconnectors, feeders.

5.6 Control of the Circuit Breakers

For all switchboards that have a two-out of three-circuit breaker scheme (i.e. two incomers and a bus section or bus coupler), make-before-break logic shall prevail in addition to the provision of automatic transfer of load from one incomer to the other incomer without affecting the running loads. Auto changeover scheme, auto manual selection, required interlocks etc. shall be provided, detail scheme shall be finalized during detail engineering as per Owner's requirement. Automatic transfers shall be blocked in case of bus bar faults, VT MCB trip, etc. Panel shall be design in such a way that Bus-A shall contains all the feeders (along with spare feeders) required for complete 0.5MLD plant-1 with Incomer and Bus-coupler to Bus-B and similarly Bus-B shall contain all the feeders (along with spare feeders) required for complete 0.5MLD plant-2 with Incomer and Bus-coupler to Bus-A. Bus-A & Bus-B shall be in single switchboard or two different switchboard for Bus-A and bus-B connected through interconnection bus coupler at both end is also acceptable.

Duplicate control voltage supplies shall be provided for each switchboard, and each infeed voltages shall be monitored and annunciate as individual alarm to DCS. Two numbers 220V



DC feeders shall be provided at PSS-1 DCDB. Bidder to arrange further arrangement (with auto change over arrangement) to utilize these feeders for complete control supply of switchboards.

In each circuit breaker plug-in units, the control voltage shall be protected by three miniature circuit breakers; tripping of the MCBs shall be indicated locally & remotely.

In each case an additional potential-free miniature circuit breaker contact shall be wired to the PLC as a group signal. DP Miniature circuit breakers shall be provided to each circuit for:

- Local controls and interlocks
- Local signals and fault indications
- Local power supply to motor-driven stored energy mechanism.

Motor space heating for all motor feeders

Space heaters with thermostat for panels

Lights and 5/15A sockets

An under-voltage monitoring device for monitoring each busbar voltage shall be provided in each distribution system and each section of busbar of the main switchgear. Motor feeders shall be tripped on bus bar under voltage after a settable time delay through hard wired interface. This device may be additionally used for the defined disconnection from the PLC of all respective low voltage motors in the case of the failure of the busbar voltage. Reclosing of the motors shall be then from the PLC.

5.7 Control of the Motor starter units

The control of the motor starter units shall be by use of 220V DC. Two numbers 220V DC supply feeders are available at DCDB of PSS-1. Further distribution from DCDB shall be done by bidder. Two infeed's with Auto changeover scheme and output shall be provided for each section of main switchgear and distribution.

The essential drives shall be automatically reconnected after drop-out due to a short time voltage dip by a dedicated program in the PLC

Motor protections shall be provided as per the National Electrical Code, IS, IEC standards, CEA regulations etc. The protective relays for motor protection should have necessarily the following minimum features:

- Short circuit protection (instantaneous)



- Locked rotor protection
- Unbalance protection
- Thermal replica/overload protection
- Earth fault protection (it shall be duly stabilized to avoid mal operation during starting condition)
- A feature with running load indicator
- Single Phasing and Reverse-phase Sequence Preventer
- Motorized MPCB or MPCB with contactor + overload relay shall be provided for small rating motor feeders.

5.8 Local Auxiliary Relays and Measuring Instruments

All auxiliary relays fix mounted, measuring instruments and relays which are sensitive to shocks shall be protected against vibration. Only DIN mounted auxiliary contactors (of approved vendor) with or without add-on block are to be provided for signaling / contact multiplication etc. Use of miniature relays / plug-in relays are not acceptable.

Multifunction cum Energy meter (0.2s class meter with 0.2s class CT and 0.2 PT if required) for incomings, Bus coupler, interconnectors feeders shall be provided. For measuring instruments only square flush-mounting types of class 1.0 (minimum other than Incomers, bus couplers, interconnectors feeders) shall be used.

As a minimum requirement, the following local measurements shall be provided:

Triple current indication of all infeed's and outgoing feeds which are equipped with circuit breakers and for all motor feeders.

Single current indication with suitable 4-way selector units with hand operated MCCBs for outgoing feeds of 250 A or more.

Voltage indication with suitable 4-way voltmeter selector for measurement of phase L1 - N, phase L2 - N, phase L3 - N, phases L1 - L3 in all incoming and bus-sections of the switchgear installations.

5.9 Remote Indications and Measurements

For remote indications, the following minimum signals shall be provided:

- Switch unit ON (for each direction of rotation and for each step of pole- changeable motors)



- Switch unit OFF
- Switch unit faulty & Trip
- Position of the local/remote selector switch
- Infeed undervoltage protection operated
- Current of each phase

For each main distribution busbar and each sub-distribution system:

- No control voltage (as group signal)
- Protection activated (as group signal for outgoing feeders)
- No busbar voltage

On, off and common fault feedback shall be provided at DCS for outgoing feeders to sub-distribution boards.

For remote measurements, the bidder shall provide current and voltage transducers which shall comply with IEC 60688 and shall have 4 - 20 mA dual output unless otherwise specified elsewhere.

All transducers shall be provided with a nameplate, indelibly marked with following min. information:

- Name of manufacturer
- Manufacturer's type reference
- Serial number
- Rate input voltage and current, as appropriate
- Overall ratio (e.g., Watts/mA).
- Outputs with terminal details

5.10 Cabling and Wiring inside the switchgear cubicle

LT Power & control cables shall be of minimum 1100 volts grade XLPE & PVC insulated flame retardant, low smoke, FRLSH conforming to IS 7098 part-1 & IS 1554 part-1. 1.1 KV grade XLPE power cables compacted aluminium / copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLSH PVC outer-sheathed conforming to IS:7098. (Part-I)



The Cable glands shall be weatherproof Double compression type made of heavy-duty brass machine finished and nickel chrome plated of suitable size. Thickness of plating shall not be less than 10 microns. Cable glands shall conform to BS:6121.

All Cable lugs for power cables shall be Heavy duty long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size. Cable lugs for control cables shall be tinned copper ring type with insulated sleeve.

All control terminals shall be of Stud type (screw drive operated) and control wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. Disconnecting stud type terminal shall be provided for CT circuits. 20% spare terminal shall be provided of each type. Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS:375. Red Ferrules should be provided on trip circuit wiring.

All wiring shall be carried out with wires of 1.1 KV grade, stranded copper conductors. The insulation shall be halogen free and flame retardant. Power circuits shall be wired with stranded copper conductors of adequate sizes to suit the rated current, the minimum size shall be 2.5 sq. mm. Unless otherwise specified, control alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 sq. mm. Space heater circuits, CT and VT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 sq. mm. Fill factor shall not be more than 40%.

5.11 Control Supply and Space Heater Supply

- An under-voltage relay to monitor control supply shall be provided. The contact of the relay shall be wired to the terminal for external use. Control Supply Failed' indication shall be provided at local as well as remotely also.
- 220V DC supply shall be used for control supply, 2 nos 220V DC Feeders are available at DCDB of GIPCL PSS-1. Bidder to provide further distribution from these feeders. Auto changeover arrangement shall be provided at MCC, Switchgear end. Feeders of each Individual bus shall be feed from respective 220V DC Bus. Dedicated DP MCB shall be provided at each feeder and each Input. If dedicated 230V AC control supply required then 415V/230V transformers shall be provided. The control transformers shall be of insulation class 'B' or better. The sizing of control transformers shall be carried out by the Vendor considering the actual load of power contactors, auxiliary contactors,



indicating lamps and other equipment including remote auxiliary relays and lamps in the circuit with 20% design margin. One pole of secondary winding shall be earthed.

- 230V AC Space heater supply shall be derived from input supply of each unit section. Necessary DP MCB to isolate and distribute the supply shall be provided. If 24V supply is required for small rating motor space / winding heating then 2 nos 415V/24V transformers shall be provided with MCCBs and auto changeover arrangement, and each transformer shall be fed from respective Bus. Necessary DP MCB to isolate and distribute the supply shall be provided. The control transformers shall be of insulation class 'B' or better. The sizing of control transformers shall be carried out by the Vendor considering the actual load of space heaters, panel lighting & sockets. One pole of secondary winding shall be earthed.
- All motors rated 22kW and above shall be provided with power supply for space heater. The circuit for motor space heater shall be wired through auxiliary NC contact of breaker/contactors/MCB.
- Each panel of MCC/DB shall be equipped with the following as required:
- Thermostatically controlled space heater(s) of SS 304 grade material with DP MCB.
- 9W LED Illumination lamp with door switch
- 5/15A 3pin socket with MCB protection.

5.12 Earthing

All metallic non-current carrying parts of the switchgear shall be bonded together and connected to the earth busbar.

All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped while door is opened or closed.

All earthing connections on withdrawable equipment shall be first make last break design, parts shall be effectively earthed until they are completely withdrawn with all power and control connections disconnected.

Provision shall be made, adjacent to the cable termination, for earthing cable armoring to the earth busbar.

Each switchboard section shall be connected to earth grid at two diagonally opposite points.

5.13 Control of the Installation

DP Miniature circuit breakers shall be provided for each circuit:

- Local controls and interlocks
- Local annunciation and fault indications



- Power supply to motor-driven stored energy mechanism.

Space heater circuit

Lighting and 5/15A socket circuit

In general, all the requirements specified for low voltage AC switchgear shall apply to 230 V safe AC,

The infeed and bus coupler circuit breakers as well as motor feeders shall also be remotely controlled through the DCS / PLC. Therefore, the required interface facilities shall be provided.

5.14 Local Indications and Remote Signalling

Each circuit breaker or outgoing contactor circuit shall be equipped with individual signal lamps or position indicators which show the following minimum switching conditions locally:

- Ammeter (for infeeds and bus couplers + Motor feeders)
- Switch unit ON
- Switch unit OFF
- Switch unit Trip - due to fault
- MCB trip.
- Control supply fail

The following minimum signals shall be additionally provided in the infeeds of each section:

- Voltmeter with selector switch for incoming voltage
- Protection activated or circuit breaker, MCCB or MCB trip common signal for outgoing feeders
- Voltmeter with selector switch for busbar voltage
- No control voltage (main ring)
- Mini circuit-breaker tripped
- Lamp test faulty and trip circuit be included.
- No busbar voltage
- Earth fault
- AC Supply fail.
- DC Supply Source-1 fail
- DC Supply Source-2 fail

All circuit breakers (in feeds and bus couplers) shall be equipped with switching operation counters.



For remote indication in through the DCS, the following minimum signals for each infeed and bus coupler circuit breaker and for each remote-controlled motor feeder:

- Switch unit ON
- Switch unit OFF
- Switch unit Trip
- Direction of motors i.e. forward and reverse
- Current (4 – 20 mA).

The following minimum signals shall be provided as group signals for each section:

- Busbar voltage (4 – 20 mA) for each bus
- No control voltage
- Protection activated/circuit breaker, MCCB or MCB trip common for outgoing feeders
- No busbar voltage

All signals for remote transmission shall be wired to separate terminal strips; changeover contacts shall be used for that purpose.

6.0 TESTS

6.1 Low Voltage Switchgear

The low voltage switchgear shall be tested in accordance with the following rules and regulations:

- IEC 60947 Low voltage switchgear and control gear
- IEC 61439 Low voltage switchgear and control gear assemblies.

Type Tests:

- Tripping limit and characteristics
- Dielectric properties
- Mechanical operation
- Overload performance
- Dielectric withstand
- Verification of temperature rise
- Verification of overload release
- Breaking capacity (standard / higher breaking very high breaking)
- Rated service short circuit breaking capacity (ICE) peak and short time
- Effectiveness of protective circuit
- Clearance and creepage distances
- Protection and degree



- Degree of Protection
- Salt spray test for a minimum duration of 500 hrs. (If applicable)

Routine Tests (minimum)

- Wiring check
- Electrical / Mechanical functional check
- Dielectric test (main and auxiliary)
- HV Test
- IR test before and after HV test
- Operation check random

The MCC and Distribution boards shall be located indoors. Type of outgoing feeders shall be as follows:

- Motors rated $\geq 110 \text{ kW} \leq 315 \text{ kW}$: Air circuit breaker (ACB)
controlled with motor protection relay and CBCT.
- Motors rated $\geq 30 \text{ kW} < 110 \text{ kW}$: MCCB & Contactor controlled
with electronic type motor protection relay and CBCT.
- Motors rated $\leq 30 \text{ kW} > 7.5 \text{ kW}$: MCCB & Contactor controlled
with electronic type over current relay (EOCR)
- Motors rated $\leq 7.5 \text{ kW}$: MPCB & Contactor controlled
with electronic Overload relay (EOLR)
- Feeders rated $\geq 630 \text{ A}$: Air circuit breaker (ACB)
controlled.
- Feeders rated $< 630 \text{ A}$: MCCB controlled

All MCCB shall be provided with inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit

6.2 Current Transformers

The current and voltage transformers shall be tested in accordance with IEC 61869-2 Instrument transformers.

6.3 Voltage Transformers

The voltage transformers shall be tested in accordance with IEC 61869-3 – Instrument Transformers.



6.4 Low Voltage Fuses

The low voltage fuses shall be tested in accordance with the following rules and regulations:
IEC 60269 Low voltage fuses.

6.5 Relays

The relays and contactors shall be tested in accordance with the following rules and regulations:

- IEC 60255 Electrical relays
- VDE 0804 Special regulations for equipment connected to telecommunication systems.



ANNEXURE – 1 SALIENT DATASHEET

S. No	ITEM DESCRIPTION	RATING
1)	Low Voltage Switchgear	
a)	Type of Construction	Form-4b, Metal Casing Floor mounted, Free standing, single/double front, compartmentalized
b)	Rated voltage	415V
c)	Maximum voltage of system	1.1 KV
d)	Frequency	50 HZ
e)	Impulse with stand voltage	-
f)	Power frequency with stand voltage	3 kV
g)	Busbar material / Insulation	Tinned Copper with Insulated sleeve
h)	Rated bus bar current at 55 deg C ambient	As applicable for the switchgears
i)	Max. asymmetric three-phase short circuit with stand current	Minimum 45 kA Peak
j)	Short-time current (1 sec)	Minimum 25 kA
k)	Type of circuit breaker	ACBs for Incomers, B/C, interconnection For other Fixed type / Moulded case Circuit Breaker
m)	Type of earthing switch	Manual operation
n)	Secondary current of current transformer	1 A
o)	Secondary voltage of voltage transformer	110/ $\sqrt{3}$ V
p)	Type of protection relays	Numerical
q)	IP Protection class of switchgear	IP 52
r)	Control voltage	220V DC
s)	Voltage for heaters	230V AC
g)	Impedance	4%



B. LV MOTORS

1.0 INTENT OF SPECIFICATION

This section covers the technical requirements of LV Motors.

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following IEC publications and other codes except where modified and /or supplemented by this specification.

IEC 60034: Rotating electrical machines.

IEC 60079: Electrical apparatus for Explosive gas atmospheres

ANSI/UL-674: Electric Motors and Generators for use in Hazardous location, Class-I Groups C & D, Class-II, Groups E, F & G

IEC 60072: Dimensions and Output Series for Rotating Electrical Machines National Electrical Code, BEE,

Motors shall also confirm to other applicable standards, CEA regulations etc amended up to date

3.0 TECHNICAL REQUIREMENTS

3.1 Design ambient temperature

Motors shall be design for an ambient temperature of 50 degree C and at site relative humidity shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2 Supply voltage

Motors rated up to and including 415V are termed as LV motors

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

Frequency variation	:	(+) 3% and (-) 5%
Voltage variation for LV motors	:	(±) 10%
Combined variation of voltage and frequency	:	10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

Electrical motor rated voltage shall depend on the rating as given below: -



- Motor DOL Pn < 160 kW 415 V, 3 phase, 50 Hz.
- Motor Soft Starter 7.5 kW < Pn < 160 kW 415 V, 3 phase, 50 Hz.
- Motor DOL special 415 V, 3 phase, 50 Hz.

3.3 System Parameters

Sl. No.	Description	LV System
1.	Fault withstand rating of motor terminal box (Breaker operated)	25 kA for 1 second

3.4 Type

AC Motors shall be squirrel cage induction type unless otherwise it is specified. If required motor shall be compatible for soft starter or DOL operation as per design requirement.

3.5 Duty

- All AC motors shall be squirrel cage three phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted places with coal ash and or fly ash.
- Duty of motor shall be decided based on number of running hours and number of starts according to Application

3.6 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- Maximum continuous motor ratings shall be at least 15% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Motor should have 15% of design margin.
- If the motor is selected with a design margin of at least 15% above the maximum load demand, a service factor of 1.0 is acceptable; otherwise, the motor shall have a minimum service factor of 1.15."
- The motor conductors should have an ampacity not less than 125% of the FLC for motors with a service factor of 1.15 or higher.



3.7 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load / Soft starter starting.
- LV motors rated up to 5.5kW will be controlled through MPCB, and above 5.5kW to 30kW shall be controlled through MCCB.
- Local Start and Emergency Stop pushbutton station (with enclosure of SS304 grade 1.5mm thick sheet steel material & minimum IP-55) shall be provided at each motor location with approachable platform for ease of local operation.

3.8 Efficiency

All the continuous duty motors shall be energy efficient type. For LV motors, it shall be premium Efficiency class- IE3, as per IEC:60034-30

3.9 Temperature rise

Winding Insulation shall be Class F With Temperature rise limited to class B

3.10 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct online starting, without exceeding specified winding temperatures.
 - LV motors : 85% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 85% of the rated voltage for 5 minutes.
- d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage for two (2) second duration

3.11 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque, and inertia.



- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).

3.12 Starting current

- For LV motors, the applicable starting current shall be limited to 6.6 times of full load current including all tolerance.

3.13 Locked rotor withstand time

- For the LV motors having starting time up to 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.
- Locked Rotor Current of the Energy Efficient LV motor will be as per IEC 60034-30

3.14 Torque Requirements

- The pull-up rotor torque of cage induction motors shall be adequate to meet the specified requirements of the driven load, but in any event shall not be less than the values given in IEC 60034.
- The starting torque at 80% voltage shall be adequate for starting the driven load under the most arduous conditions, such as open fan vane or open pump discharge valve.
- The accelerating torque at any speed and 80% rated voltage shall be not less than 10% of motor rated full load torque. In any event the motor starting torque at 100% rated voltage shall be not less than 1.7 times the torque obtained from a load curve which varies as the square of the speed and is equal to 100% torque at rated speed.



- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction
- The motors shall also be capable of delivering rated torque when running at 70% nominal voltage for a period of ten (10) sec.
- The margins between the torques of the motors and driven plant shall include suitable allowances for impeller wear, fouling and similar occurrences during the life of the plant

3.15 Enclosure

All motor enclosures shall conform to the degree of protection IP 55 for Outdoor Motors and IP 54 for indoor Motors. unless otherwise specified. Motor and MOV for outdoor or semi outdoor service shall be of weatherproof construction with FRP extended canopy / rain wood shall be provided.

3.16 Cooling

- LV motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- CI fan shall be provided for each motor.
- The Alarm switch contact rating shall be minimum 5A at 230 V AC.

3.17 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere. Winding material shall be high grade copper.
- For the soft start operated drives, insulation shall be designed to take care of stresses due to high dV/dt and other factor. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.

3.18 Bearings

- Motor shall be provided with High temperature withstanding antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided



with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Guaranteed life of bearings shall be minimum 40000 hrs.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 15KW and above re-lubrication facility shall be provided. High performance, high temperature, premium quality mineral oil-based grease with temp. range of 150 deg C shall be provided for each bearing used in motors.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors shall have insulated bearings/ insulating end shield to prevent flow of shaft currents.

3.19 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads.



- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker-operated motors and shall be provided with explosion vent.
- For contactor operated LV motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel.
- Cable spreader box shall be provided for larger cable sizes.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LV motors, terminal box shall be located on top, unless otherwise specified.
- A separate terminal box of IP 55 degree of protection shall be provided for space heating of motor.
- Terminal box shall be rotatable at all direction @ 90-degree frame.
- Terminal Box shall be suitable for connecting cable one size higher than design sized cable with 4-core aluminum XLPE insulated PVC sheathed armour cable with sufficient space for cable lead arrangement.

3.20 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, Tinned copper bolts and washer. The terminal box shall have a separate grounding terminal. Each Motor earthing terminals shall be connected to nearest earth grid through suitable sizes copper strip or copper wires only.

3.21 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IEC 60034-9.



- The peak amplitude of the vibration shall also be within the specified limits of IEC 60034-14.

3.22 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IEC 60034-1 and IEC 60034-30.

In addition to the minimum information required by IEC the following information shall be shown on motor rating plate:

- Temperature rise in °C under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.
- Frame Size, Insulation class, PF, Efficiency, RPM, Rated KW, Voltage and Current, space heater voltage and current etc.

3.23 Drain plug

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

3.24 Lifting provision

All Motors shall be provided with eyebolt or other adequate provision of lifting. Sufficient space for motor installation, maintenance and replacement shall be provided at each motor location. Suitable motor lifting and shifting arrangement shall also be provided for each motor locations to connecting road.

3.25 Dowel pins

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment

4.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy-based paint. The final thickness of paint film on steel shall not be less than 240 microns. Paint Shade for the Motor shall be RAL 7035 or RAL 5009. Enough touch-up paint shall be furnished for application at site.



5.0 TESTING AND INSPECTION

5.1 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give at least fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

5.2 List of the Tests (Routine Tests/Acceptance Tests/ Type Tests & Site Tests) to be performed on the Motors as per IEC Standards.

The following minimum type tests shall be conducted on LT motors.

- Measurement of resistance of windings of stator and wound rotor.
- No load test at rated voltage to determine input current power and speed
- Full load test to determine efficiency power factor and slip.
- Temperature rise test.
- Momentary excess torque test.
- High voltage test.
- Test for vibration severity of motor.
- Test for noise levels of motor
- Test for degree of protection
- Over speed test.

5.3 For each type and rating of electrical equipment, bidder shall submit drawings, GA, GTP, sizing calculations, QAP, MQAP, FAT, SAT, characteristic curves, etc for Owner's approval, and the reports for all the type tests as per relevant standards and carried out within last 5 years from the date of bid opening. These reports shall be for the tests conducted on the equipment similar as per standard to those proposed to be supplied under this contract and the tests should have been conducted in a Govt. /independent laboratory. Otherwise, the bidder shall conduct the type tests without any extra cost to the Owner and submit the TC's for acceptance.

6.0 DRAWINGS, DATA AND MANUAL

To be submitted after the award of contract:

- Filled in technical Schedules, GTP, DATA Sheets
- Dimensional General Arrangement drawing
- Characteristic curves
- Foundation details
- Terminal box details
- Quality Plan, MQAP, FAT, SAT
- Type test certificates
- Installation manual
- O&M manual



C. ELECTRICAL INTEGRAL ACTUATORS

1.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical integral actuators.

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the applicable IEC publications and other codes except where modified and /or supplemented by this specification.

3.0 TECHNICAL REQUIREMENTS

3.1 Electric actuators shall be provided where specified/required. It shall be equipped with 3 phase induction motor, rated for intermittent duty S4-25%.

3.2 Motor shall be of class H insulation with temperature limited to class B.

3.3 Motor shall be surface cooled designed for enclosure protection class of IP 68. Motor shall be suitable for starting direct on line.

3.4 Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

3.5 Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : ($\pm$) 10% of 415 V
- Combined variation of voltage and frequency : 10% (absolute sum)

3.6 All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

3.7 Actuators shall be of totally enclosed weatherproof and dust proof construction with NEMA-6/IP 68 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur



gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.

- 3.8 The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.
- 3.9 Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.
- 3.10 Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.
- 3.11 Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weatherproof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 230 Volts AC, 10 A and 220 V DC, 0.5 Amps. Minimum 2 NO and 2 NC contact wired upto TB shall be provided as spare for each type of limit switches.
- 3.12 Each actuator shall have a space heater in the limit switch compartment suitable for 230 V AC 50 Hz single phase supply.
- 3.13 The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.
- 3.14 Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature.



3.15 A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided. Open, Close and Emergency Stop pushbutton station (with enclosure of SS304 grade 1.5mm thick sheet steel material & minimum IP-55) shall be provided at each actuator location with approachable platform for ease of local operation.

3.16 The Remote command signal (OPEN-STOP-CLOSE) from DCS/PLC/Control panel shall be isolated from control electronics through opto-isolator.

The following minimum individual status annunciation LED's indicating lamp shall be provided locally (Integral to actuator) to annunciate the following for easy local as well as remote monitoring.

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Torque Limit switch OPEN trip
- Torque Limit switch CLOSE trip
- Control voltage availability
- Emergency stop,
- % feedback for both open as well as close positions

3.17 View port shall be provided on integral starter unit to monitor the above status annunciation.

The following minimum individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

3.18 View port shall be provided on integral starter unit to monitor the above status annunciation.



3.19 Suitable GS platform shall be provided for O&M, repair and replacement of each actuator location. Actuator lifting & shifting arrangement upto connecting road shall also be provided at each actuator location.

3.20 Electronic overload relay shall be provided to trip actuator in case of overload.

Plug in connections/design shall be provided between: -

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip,

Thermo switch trip and thermal overload relay trip

- Emergency stop,
- % feedback for both open as well as close positions

4.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards. All applicable type test reports shall be submitted for review. It shall not be older than 5 years from the date of bid.

Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give at least fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.



5.0 TECHNICAL PARAMETERS

Sl. No.	DESCRIPTION	UNIT	PARAMETERS
1.	Service		Indoor / Outdoor
2.	Design ambient temperature	°C	50
3.	Applicable standard		IS 12615 & IEC 60034
4.	Rated voltage		415 $\pm$ 10%, 3 phase
5.	Rated Frequency	Hz	50 (+3, -5%)
6.	Class of Insulation for all Motors except actuator motors		Class 'F' with temperature rise limited to Class 'B'
7.	Starting Current for DOL Starting		6.6 times of FLC
8.	Degree of protection		IP-54 for motor. IP-55 for connection box
9.	Make of Motor		1. Siemens 2. CGL 3. Kirloskar 4. ABB
10.	Rated KW / HP	KW / HP	
11.	Rated Current	A	
12.	P.F.		
13.	Efficiency a. At 50% load b. At 75% load c. At 100% load Maximum Efficiency & load	%	
14.	Frame		
15.	RPM		
16.	DE Bearing Details		
17.	NDE Bearing Details		
18.	Make of Bearing		SKF
19.	Bearing temp. withstanding limit		



Sl. No.	DESCRIPTION	UNIT	PARAMETERS
20.	Space Heater details – Watt, V, Amp		
21.	Max. Operating Temp.		
22.	Make of Actuators		1.0 Limitorque 2.0 Auma India 3.0 Rotary Beacon
23.	Shaft earthing required or not		
24.	Motor Earthing details		
25.	Spare Motor	Nos	10% or minimum 1 No of Motor of each Type and Rating
26.	Spares for Actuator	Nos	10% or minimum 1 no of each type and rating complete actuator + 10% or minimum 1 no actuator motor of each type and rating



D. LV POWER AND CONTROL CABLES

1.0 INTENT OF SPECIFICATION

This section covers the requirements of LV Power and Control cables.

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and / or supplemented by this specification.

- | | |
|---------------------|---|
| a) IS: 3975 | Mild steel wires formed wires and tapes for armouring of cables. |
| b) IS: 4905 | Methods for random sampling. |
| c) IS: 5831 | PVC insulation and sheath of electric cables. |
| d) IS: 7098 Part-I | Cross-linked polyethylene insulated PVC sheathed cables (LV) |
| e) IS: 8130 | Conductors for insulated electric cables and flexible cords. |
| f) IS: 10418 | Drums for electric cables. |
| g) IS: 10810 | Methods of tests for cables. |
| h) IS: 3961 | Recommended current ratings for cables |
| i) ASTM-D-2843 | Standard test method for density of smoke from the burning or decomposition of plastics |
| j) ASTM-D-2863 | Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics. |
| k) IEC-754 (Part-I) | Test on gases evolved during combustion of electric cables. |
| l) IEC-332 | Tests on Electric cables under fire conditions Part-3: Tests on bunched wires or cables (category -B) |
| m) IEEE-383 | Standard for type test of Class IE Electric Cables. |

3.0 TECHNICAL REQUIREMENTS

3.1. Power cables shall be sized to satisfy the following Criteria:

- Short circuit withstand capacity for applicable fault current and duration of 1 sec.



- Full load current carrying capacity under installation conditions considering design Site ambient temperature of 50 deg C & site installation (Grouping & other deratings) conditions based on Manufacturer's recommendation.
 - Permissible voltage drops limits under steady state/transient state as applicable.
 - All LT cables shall be of minimum 1100 V grade, single/multi-core, stranded compacted aluminium / copper conductor, extruded XLPE insulated (hot water cured), with extruded PVC inner sheath (Type ST-2), GI strip armoured and overall sheath with extruded Flame-Retardant Low Smoke (FRLS) compound (Type ST-2) conforming to IS:7098. (Part-I). All the cables shall be protected against Fungus, rodent and termite attack. Necessary chemicals shall be added into the outer sheath compound of the outer sheath. The sheath shall be resistant to saline water, UV radiation, fungus, etc.
- 3.2. For breaker operated feeders, short circuit withstand duration for conductors shall be not less than 1 sec for motor feeders, and not less than 1 sec for incomer feeders in general.
- 3.3. To maintain voltage at motor terminals /equipment end within desirable limit, it is proposed to limit the voltage drop in the cables within 3% during normal running condition and 10% during starting of Motor.
- 3.4. Cables can be GS strip armoured type only.
- 3.5. Power cables and control cables shall be XLPE insulated.
- 3.6. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.
- 3.7. Cables for 415/230 V AC shall be rated for 1.1 kV grade.
- 3.8. To minimize the damage that can be caused by a fire, cables installed in electrical cable tray systems shall have sheaths which have zero halogen, low smoke, non-propagating, and self-extinguishing characteristics. Outer sheath shall be of PVC black in colour for power cables and blue for control cables. These cables shall meet the following test requirements.
- Oxygen index of minimum 29 when tested as per IS 10810 Part-58 / ASTM D-2863/1977
 - Temperature index of minimum 250°C when tested as per IS 10810 Part-64// ASTM D-2863/1977
 - Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 / IEC-754-I



- Average light transmission of 40% minimum when tested as per IS 10810 Part-63 / / ASTM-D-2843/1977. (Average smoke density is maximum 60%)
 - Flame test requirements as per IS 10810 Parts-53 and 62, IEEE-383-1974, IEC-332-1 & SS-4241475, Class-F3
 - Flame retardant test requirements as per IS 10810 Part-61
 - Halogen content requirements as per IEC 60754
 - Smoke density rating shall not be more than 60 % (as per ASTM-D-2843)
- 3.9. For power cables, 415 V power cables will be 1100V grade with stranded conductor (minimum size will be 2.5 sq.mm & above will be copper and above 25 sq.mm for aluminium), XLPE insulated, extruded PVC inner sheathed, galvanized steel wire armoured, and overall PVC sheathed. Copper cable of suitable size shall be provided for Motors of rating 15KW and below.
- 3.10. Control cables shall be multicore 1100V grade, XLPE insulated, PVC inner sheathed galvanized steel strip armoured and overall PVC sheathed with 2.5sq.mm stranded copper conductors
- 3.11. Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.
- 3.12. Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.
- 3.13. Power cables shall be sized to withstand the fault current of the circuit for the fault clearing time indicated below:
- LV MCCB operated motor feeders & outgoing feeders: 1 second.
 - Tie between two 415 V switchboards: 1 second.
 - Incomers: 1.0 second.
- 3.14. The voltage drop from the incomer to motor terminals during the starting of motors shall be limited to the following values:
- For LV motors: 10% of the rated voltage.
- 3.15. The entire system shall be designed such that the total voltage drop during the starting of highest size Motors shall not exceed 10% of the rated voltage.



- 3.16. The conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.
- 3.17. For multicore armoured cables, armouring shall be of galvanized steel strip. For single core cables Aluminum wire armour shall be provided.
- 3.18. No Joints shall be permitted in any of the control cables. For Power cable joint shall only be permitted if single cable length as per OEM manufacturing capability does not meet the requirement.
- 3.19. All the cables shall be protected against rodent, fungus and termite attack. Necessary chemicals shall be added to the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.
- 3.20. Water swellable tap shall be provided for all cables laid underground.
- 3.21. Multi-core cable colour coding shall be as follows:
- Red, yellow, blue, black, and grey for five core cables
 - Outer sheath shall be of black for power cable and blue for control cables.
 - For more than 5 cores, core identification shall be by alphanumerical numbering system at an interval of one meter.
- 3.22. Multicore 1.1 kV earthed grade cables shall constitute the following as per IS-7098-Part-1:
- Circular / shaped, stranded aluminum conductor (compacted for >6 sq. mm)
 - Extruded XLPE insulation
 - Extruded PVC inner sheath
 - Galvanized steel formed wire/strip
 - Extruded FRLS PVC outer sheath
- 3.23. Multicore 1.1 kV earthed grade control cables shall constitute the following as per IS:1554-1:
- Multi stranded annealed copper conductor
 - Extruded PVC insulation
 - Extruded PVC inner sheath
 - Galvanized steel formed wire/strip
 - Extruded FRLSH PVC outer sheath



3.24. Multi pair 1.1 kV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanized steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.25. Cable drums

Cables shall be supplied in non-returnable drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails to eliminate ingress of water during transportation, storage, and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

Each drum shall contain minimum 500 meters single length of cable. Allowable tolerance on individual drum length is +5%.

Cable identification shall be provided by embossing & printing on every 3-meter on the outer sheath the following:

- a) Manufacturer's name or trademark
- b) Voltage grade
- c) Year of manufacture
- d) Type of insulation and sheath, e.g., XLPE FRLS as applicable.
- e) Type of improved fire performance, e.g., FRLS
- f) No. of core and size of cables.
- g) Reference Standard
- h) ISI Mark
- i) Sequential length marking at an interval of 1m throughout the length of the cable.
- j) GIPCL



3.26. Packing

Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose.

A label shall be securely attached to each end of the reel indicating the details mentioned below.

A tag containing the same information shall be attached to the leading end of the cable inside. Drum numbers are to be indicated on cable drums.

The cable drums should carry the following details in printed form (non-returnable):

- a) Manufacturer's name or trade make.
- b) Type of cable & voltage grade
- c) Year of manufacture
- d) Type of insulation / sheath e.g., XLPE, FRLS as applicable.
- e) No. of core and size of cables
- f) Cable code
- g) Length of cable on drum
- h) ISI Mark
- i) Direction of rotation, by arrow
- j) Approx. gross mass.
- k) IS/IEC number.

3.27. Tests

Cables offered shall be type tested and proven type.

All tests, i.e., routine, acceptance & type tests including special FRLS type & acceptance test shall be witnessed by Owner and/or Owner's representative. The Contractor shall give at least fifteen (15) days advance notice of the date on which the tests are to be carried out.

Acceptance tests shall be carried out on 1 drum out of every 10 or a smaller number of drums selected on random basis from each lot for each type & size of cable.

Type tests shall be carried out on 1 drum per each lot selected on a random basis for each type & size of cable.



Type & size shall mean voltage grade, type of insulation, and no. of cores read in conjunction with an area of cross section of the conductor.

4.0 TECHNICAL PARAMETERS

LV Power Cable

Sl. No.	Description	Parameters
1	Service Voltage	0.415 kV $\pm 10\%$, 50 Hz (+3 % to -5%)
2	Earthing system	Solidly earthed
3	System short circuit current	50 kA
4	Voltage designation of cables	1.1 kV earthed grade
5	Type of cable	FRLSH
6	Standard applicable	IS : 7098, Part - I
7	Conductor a) Material b) Strands c) Shape	a) Electrolytic grade Copper / Aluminium H2 grade, class 2 b) As per IS : 8130 c) Sector shaped for multi core cables 25Sq.mm and above (optional)
8	Insulation a) Material and standard b) Application c) Volume resistivity	XLPE Extruded As per IS : 5831
9	Identification of Cores	Colour coded as per IS : 7098 (red, yellow, blue, black)
10	Inner sheath for multi-core cables	Extruded PVC type ST2 (IS : 5831)
11	Armour material a) Multi-core cables b) Single-core cable	Galvanised steel wire / strip conforming to IS : 3975 (minimum coverage of 90%) Hard drawn aluminium wire H4 grade, as per IS : 8130 (minimum coverage of 90%)
12	Outer sheath a) Material and standard b) Application c) Colour	FRLSH PVC type ST2 (IS : 5831) Extruded Black
13	Standard drum length	1000/ 500 m $\pm 5\%$ unless otherwise specified.



CONTROL CABLE

Sl. No.	Description	Parameters
1	Service voltage	0.415 kV $\pm$ 10%, 50 Hz (+3 % to -5%)
2	Earthing system	Unearthed
3	Voltage designation of cables	1.1 kV Unearthed grade
4	Type of cable	FRLSH
5	Standard applicable	IS : 1554
6	Conductor a). Material b). Strands	Multi stranded annealed copper As per IS : 8130
7	Insulation a). Material and standard b). Application c). Volume resistivity	PVC Extruded As per IS : 5831
8	Inner sheath	Extruded PVC type ST1 (IS : 5831)
9	Armour material	Galvanised steel wire / strip conforming to IS : 3975 (minimum coverage of 90%)
10	Outer sheath a). Material b). Application c). Colour	FRLSH PVC type ST1 (IS : 5831) Extruded Blue



E. CABLE TRAYS, SUPPORTS & ACCESSORIES

1.0 INTENT OF SPECIFICATION

This section covers the requirements of GS Cable trays & GI Supports, GI accessories. List of items shall include the following:

- Ladder type Cable trays
- Perforated type Cable trays
- Cable Tray bends, Tees, Cross, Coupler plates, etc.
- Cable tray covers.
- Bolted (Uni strut type) cable tray support system.
- Erection hard wares

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, except where modified and /or supplemented by this specification.

- IS: 1079 Specification for hot rolled carbon steel sheet and strip.
- IS: 1730 Dimensions for steel plates, sheet strips and flats for general engineering purposes.
- IS: 1363 Hexagon head bolts, screws, and nuts.
- IS: 6005 Code of practice for phosphating iron & steel.
- IS: 2629 Recommended practice for hot dip galvanizing on iron and steel.
- IS: 2633 Methods for testing uniformity of coating on zinc coated articles.
- IS: 6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
- IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
- IS:4759 Specification for hot-dip zinc coatings on structural steel and allied products

3.0 TECHNICAL REQUIREMENTS

3.1 Cable Trays

Cable trays shall be ladder type for power and electrical control cables and perforated type for signal cables, prefabricated and hot dip galvanized, made of galvanized steel sheets, complete with matching fittings, accessories and hardware as required. Cable trays shall be with standard width of 150mm, 300mm, 450mm, 600mm and standard lengths of 2.5m or more. Minimum thickness of galvanized steel sheets used for fabrication of cable trays and fittings shall be 2mm with coupler plates of 3mm. For ladder trays, rung thickness shall be 2mm. The thickness of side coupler plates shall be minimum 3mm and of tray covers shall be minimum 2mm.



- 3.1.1 Separate cable trays shall be provided for the following cables:
- LV Power cables
 - Control cables
 - Communication cables
- 3.1.2 Cable trays shall be complete with matching fittings and accessories (like elbows, bends, reducers, tees, crosses, side coupler plates, etc.) and hardware (like bolts, nuts, washers, etc.) as required. At both the ends of cable trays, four holes shall be provided for fixing side coupler plates. All the slots and coupler holes shall be machine punched.
- 3.1.3 Cable trays, fittings, supports, hardware and accessories shall be hot dip galvanized. Thickness of galvanizing shall be not less than 110micron. Fasteners like bolts, nuts, spring & screws washers etc. shall also be hot dip galvanized.
- 3.1.4 For branch cabling routes involving fewer cables, sheet steel galvanized cable trough of size 50/75/100mm shall be provided.
- 3.1.5 Cable tray covers shall be provided for trays (bottom & Top). It shall be prefabricated made of hot/cold rolled galvanized iron sheets, complete with hardware as required. Tray cover shall be hut type with minimum 5 mm overlap with cable tray at both sides. Special clamps shall be provided for fixing tray covers without drilling holes on trays. Cable Trays, its covers & all accessories etc. shall be hot dip galvanized. Thickness of galvanizing shall be not less than 110micron.
- 3.1.6 Load Test for Cable trays shall be carried out as follows:
A 2.5-meter straight section of each type of cable tray shall be simply supported at the two ends. A uniformly distributed load of 100 kg per meter shall be applied along the length of tray. The maximum deflection at mid-span shall not exceed 7 mm. Cable trays arrangement shall be as per IS standard.

4.0 CABLE TRAY SUPPORT SYSTEM

- 4.1. Cable tray supports shall be ISMC Channel/Angle Support & shall be hot dip galvanized steel sheet. Thickness of galvanizing shall be not less than -110micron.
- 4.2. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.



- 4.3. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts, and other hardware etc. of the components shall not be allowed.
- 4.4. Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 1000 mm. Vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 600 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 600mm.
- 4.5. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.



F. CABLING ACCESSORIES

1.0 INTENT OF SPECIFICATION

This section covers the requirements of cabling accessories. List of major items shall include the following:

- Cable joints & terminations
- Cable glands
- Cable lugs
- Camps
- Tags
- Conduits & Pipes
- Junction boxes

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and /or supplemented by this specification.

- a) VDE 0278 : Joints and Terminations
- b) IS: 13573-1 : Cable accessories for extruded power cables - Specification Part 1 for working voltages from 1.1 kV up to and including. 3.3 kV(E) - Test methods and test requirements (First Revision)
- c) BS:6121 : Mechanical cable glands (Part 1 -Specification for metallic glands)
- d) IS: 12943 : Brass Glands for PVC Cables
- e) IS:8309 : Specification for compression type tubular terminal ends for aluminium conductors of insulated cables.

3.0 TECHNICAL REQUIREMENTS

3.1 Joints & Terminations

- 3.1.1 Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight-through joints shall form part of the kit.
- 3.1.2 Termination and jointing kits shall be suitable for the following types of cables as per IS and shall be suitable for 0.6/1.1 kV grade power cables.
- 3.1.3 Termination kits and jointing kits shall be 'heat shrinkable type'.
- 3.1.4 Straight-through joint and termination shall be capable of withstanding the fault level of 50



kA for LV Cables.

- 3.1.5 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.
- 3.1.6 Cable jointer shall be qualified, experience and approved by OEM to carryout satisfactory cable jointing/termination.
- 3.1.7 Jointing and termination kit shall be Raychem RPG make only.

3.2 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression type for Armoured cables. For flame proof equipment cable glands shall be of flame proof type.

The Cable glands shall be weatherproof Double compression type made of heavy-duty brass machine finished and nickel chrome plated of suitable size. Thickness of Nickel plating shall not be less than 10 microns. Cable glands shall conform to BS:6121. For flame proof equipment cable glands shall be of flame proof type. Removable type gland plates shall be provided as per the requirement. This is applicable to all equipment

3.3 Cable lugs

- 3.3.1 Cable lugs shall be tinned copper. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solderless crimping type.
- 3.3.2 Cable lugs for conductors of power cables shall be "heavy duty long barrel" type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable. All Cable lugs for power cables shall be double compression type Heavy duty Long barrel tinned copper ring type / bimetallic solderless crimping type of suitable size.
- 3.3.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be tinned copper ring type with insulated.
- 3.3.4 Type of cable lugs shall be as follows:
 - Power cables with aluminium conductor : Tinned copper / Bimetallic crimping type.
 - Power cables with copper conductor : Copper crimping type.
 - Control Cables : Tinned Copper Ring type



3.4 Cable Clamps

Cable laid on supporting angle in cable trenches, structures, columns, and vertical run of cable trays shall be suitably clamped by means of G.I. saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Suitable size Die cast Aluminum or Fibre glass or Nylon clamps with all fixing GI accessories shall be provided for clamping of multicore and other cables at every 5 meters interval.

3.5 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of embossed type over the cables.
- Tags shall be of durable quality of size 60mm x 12mm with a tie hole at each end.
- Cable tags shall be 2.00mm thick of SS-304/Aluminium alloy. Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire (Nylon tie or equivalent) of sufficient strength for tagging.



G. UNINTERRUPTED POWER SUPPLY SYSTEM

1.0 INTENT OF SPECIFICATION

This section covers the requirements of 230V UPS system.

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards, except where modified and /or supplemented by this specification.

- | | | |
|----|----------------|---|
| a) | IEC: 62040 | Uninterruptible Power Systems (UPS) |
| b) | IEC 60146-1-1 | Mono crystalline semiconductor rectifier cells and stacks. |
| c) | IEC 60119 | semiconductor rectifier assemblies and equipment. |
| d) | IEC 61007:2020 | Transformer and inductors for electronic equipment |
| e) | IEC 60947 | LV switchgear and control gear |
| f) | IEC 60748 | semi-conductor devices and integrated circuits |
| g) | IEC 60068 | Basic Environmental Testing Procedures for Electronic equipment |
| h) | IEEE 519 | Recommended practices and requirements for harmonic control |

3.0 DESIGN REQUIREMENTS

3.1.0 UPS system shall be Digital type. It shall provide uninterrupted power supply to critical AC loads to Desal plant

3.2.0 UPS, which will be in air-conditioned area, shall be designed for design ambient temperature of 30°C. Other equipment shall be designed for design ambient temperature of 50°C.

3.3.0 UPS shall consist of chargers, inverters, Battery, SMPS based static voltage stabilizer, Static bypass and Maintenance bypass, UPS DB, MCCB box for battery, interconnecting cables among UPS & static voltage stabilizer etc.

3.4.0 UPS shall be in Air-conditioned room.

3.5.0 Battery shall be Ni-Cd type.

3.6.0 UPS battery shall be rated for 60 minutes back up



3.7.0 UPS shall have features not limited to the following:

- Digital Technology
- True online double conversion
- High frequency PWM design
- Programmable power walk-in
- High efficiency
- High input power factor
- Constant voltage & frequency
- Pure sine wave output power with no break output during normal to battery operation
- Wide frequency synchronizing range
- Wide input range
- Soft start capability
- 100% nonlinear load handling capability
- LED mimic
- LCD Display
- RS 232 /RS 485 Interface complete with Communication software
- Permissible harmonics at rated continuous load +/- 2% for linear loads & 3% for non-linear loads.

3.8.0 UPS shall be suitable for connecting to a 415V, 3 phase, 4 wire, 50Hz system with a symmetrical fault level of 50kA rms. Nominal voltage output shall be 230V, 50Hz, Single phase with +/- 1% resolution.

3.9.0 Variation in inverter output voltage and frequency shall not exceed specified limits for the load variation between zero and the rated output of the UPS and also for the following input supply variation.

- For the input power supply condition of 415 V +/- 10% and 50 Hz +3%, -5%
- For the DC input voltage over the range corresponding to battery float / boost charge operation and battery operation and battery discharge operation up to battery end cell voltage.

3.10.0 The changeover from inverter to by-pass transformer shall not be more than 5 ms.

3.11.0 The design shall provide for high availability of equipment by ensuring high mean - time - between failures (MTBF) and low mean-time-to-repair (MTTR).

3.12.0 The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 sec. The inverter shall have sufficient I^2t capability to clear fault in the



maximum rated branch circuit. The sizing of UPS shall be based on the power factor of the loads being fed subject to a maximum of 0.8.

3.13.0 On failure of one UPS, the other UPS will take over the 100% load automatically without any interruption and on failure of both UPS, STATIC VOLTAGE STABILISER will take over the power supply distribution and will supply the power without any interruption.

4.0 TECHNICAL REQUIREMENTS

4.0.0 The UPS system including the stabilized bypass shall be galvanically isolated from input power supply system by providing double wound Isolation transformers. A rectifier shall have a double wound transformer at its input.

4.1.0 Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surge & voltage spikes.

4.2.0 The UPS shall be provided with automatic sequence and power walk in circuits with adjustable time delay such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.

4.3.0 The inverters shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current waveform having a relative harmonic.

4.4.0 It shall be possible to vary the inverter output voltage stepless within $\pm 5\%$ of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.

4.5.0 UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability. The UPS shall be designed to permit ready access to power switching and control modules and PCBs. The locations of components, test points and terminals shall be such that they are accessible for circuit checking adjustment, trouble shooting, and maintenance from the UPS without removal of any adjacent module or assembly.

4.6.0 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided. The load



transfer devices shall comprise of continuous rated static elements in both inverter and stabilized bypass supply.

- 4.7.0 The inverters shall be phase locked to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within + 3 % to – 5% of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be delinked from mains. Free running frequency tolerance limit shall not exceed $\pm 1\%$. Facility shall also be provided for adjustment of synchronizing frequency from 1% to 5% in the steps of 0.5%.
- 4.8.0 All electronic power devices including thyristors, transistors, diodes etc., shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc., shall be rated for at least 125% of the maximum required rating. No electronic device shall be subjected to PIV greater than 50% of the rated value.
- 4.9.0 All the thyristors, diodes and other electronic devices of UPS shall be protected with high-speed semiconductor fuses. I^2 / t co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.
- 4.10.0 Radio Frequency Filters shall be provided at the input and output of UPS to reduce radio frequency interference.
- 4.11.0 All PCBs shall be provided with a transparent epoxy coating for environmental protection and topicalization. They shall be suitably located away from heat sources.
- 4.12.0 Maximum noise level from UPS system at 1 meter distance, under rated load with all normal cooling fans shall not exceed 65dBA.
- 4.13.0 MCCB shall be TPN type for incoming supply to Rectifier circuit & Standby source, DP type for battery & ACDB incomer/outgoing. It shall be quick make, quick break, and independent manual type with trip free feature. All MCCB shall have the following:
- Short circuit release
 - ON/OFF Trip position indicators
 - Test trip push button
- 4.14.0 Copper cable shall be used for interconnection among UPS & STATIC VOLTAGE STABILISER.



5.0 MODE OF OPERATION

5.1.0 Normal Mode

- a) During the normal operation the UPS shall be used to provide power to the critical loads. Under normal conditions, the loads shall be supplied by the inverters. The Rectifier shall derive power from normal/primary AC source and supply DC Power to the inverters. Two (2) nos. Chargers shall feed regulated DC power to their individual inverter banks and simultaneously float charge the backup batteries.
- b) The individual inverters shall operate in parallel and shall share the load equally. The inverters shall be connected to load side through static switches. Outputs of the inverters are paralleled after the static switches and connected to load bus.

5.2.0 Emergency Mode

- a) Upon failure of the normal AC source, the loads shall continue to be supplied by inverters which, without any switching shall obtain their power from storage battery. In case of failure of the main supply, battery shall supply back up DC power to UPS system for duration of sixty (60) minutes.
- b) Upon restoration of the normal AC source, the rectifier/battery chargers shall power the inverters and simultaneously recharge the battery. This shall be automatic causing no interruption to critical loads.
- c) On failure of an inverter due to any one of the following faults the entire load shall be automatically transferred to the other inverter.
 - Excess inverter output voltage
 - Very low inverter output voltage
 - Failure of inverter.
- d) On failure of one inverter, the faulty one shall be isolated from load instantaneously, and the other inverter shall continue to feed the load. In case, the other inverter also fails, automatic change over to standby transformer shall be affected through static switches.
- e) Parallel operation (load sharing) shall start automatically when the fault condition clears. If the transfer was due to the inverter failure the retransfer (parallel operation) shall be manually initiated.



- f) The entire load shall be automatically transferred to the alternate AC source through static switch within a maximum of four (4) milliseconds under the following conditions:
 - Battery discharged completely
 - Initiation of manual control switch.
 - Failures of both the inverters
 - Inverter output voltage is more than +/- 5 % of the rated value
 - The load current exceeds specified overload rating and time.
- g) In case of failure of both inverters, static transfer switch shall changeover within five (5) milliseconds to connect the alternate AC source to the load. On restoration, the retransfer shall be manually initiated.
- h) Retransfer of load shall be accomplished automatically by synchronizing the inverter to the alternate source and allowing the inverter to ramp into the load and then disconnecting the alternate source.
- i) Manual transfer facility through static transfer switches shall be provided in either direction.
- j) In case of maintenance requirement, it shall be possible to isolate inverters and static bypass switches from load and connect alternate AC source to the load through manually operated, make before breaking manual transfer switch.

6.0 EQUIPMENT DETAILS

6.1.0 Charger

6.1.1 Charger shall have following features:

- Switch mode rectifier/Phase controlled rectifier
- DC constant voltage, Constant current
- IGBT/SCR power device
- Advanced electronic protection device backed up with MCCBs and fast acting fuses
- Soft start
- Built in Harmonic suppression
- Active power factor correction

6.1.2 These chargers shall be of static type and shall be provided with suitable full wave thyristors rectifiers, transformers, filter circuits, DC & AC Switchgear. Chargers shall share automatically the load during parallel operation of the inverter system and shall maintain output voltage within plus or minus one percent of the nominal value from no load to full load.



- 6.1.3 The rectifiers / chargers shall be designed to completely charge the battery in a maximum time and 4 hours for SMF VRLA batteries, after complete discharge. Facilities shall be provided to initiate battery rapid charge operation by Manual & Automatic means. An auto charging sequence should be provided for the boost and float charging based on current sensing. In addition to above, the charging shall be transferred from boost to float mode after preset time adjustable through 0-24 hour's timer. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.
- 6.1.4 Facility shall be provided to enable testing of rectifier independently without disconnection of inverter.
- 6.1.5 Facility for initial charging of batteries shall also be provided. The inverters shall be disconnected during initial charging of the battery.
- 6.1.6 The rectifiers shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8pf lagging and recharge the battery to nominal rated capacity of the battery. The DC load imposed by the inverters shall be considered under the worst case where only one rectifier is operating but the UPS load is equally shared by all the inverters.
- 6.1.7 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. After a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.
- 6.1.8 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content shall not exceed 1.5%. Ripple current relay shall be provided to indicate the charger capacity failure.
- 6.1.9 Battery shall be provided with a sensitive earth leakage protection.
- 6.1.10 The chargers shall be current limiting and shall be provided with surge suppression networks for both float and boost charging. All equipment and devices required to protect the chargers from short circuits e.g. fast acting semiconductor fuses, trip fuses and micro switch



with alarm contacts etc., shall be provided. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

6.2.0 Inverter

6.2.1 Inverters shall have following features:

- Digital PWM IGBT design
- Advanced electronic protection device backed-up with MCCBs and fast acting fuses.
- High speed pulse balancing electronic over voltage/under voltage protection
- Electronic overcurrent trip with reset.

6.2.2 Inverters shall be PWM controlled IGBT (Insulated gate bipolar transistor), static filters, necessary oscillators, voltage regulators, current limiting and surge suppression networks. Two (2) nos. 100% capacity Inverters shall be provided. In addition, the inverters shall have features of soft start, wave shaping, transient recovery etc. Any other equipment required for normal operation of the inverter shall be included irrespective of whether specified or not.

6.2.3 The inverter input voltage shall match with the battery and rectifier charger output voltages and shall be designed to operate over the entire range of variation of input DC voltage to accommodate decrease in battery voltage during discharge and to accept voltage increase under battery boost charge or equalizing charge conditions. The output from the inverter shall be 230V AC, sine wave 1 phase.

6.2.4 The inverters shall always work on their internal oscillators or frequency variations with plant AC electrical system. Output voltage frequency shall be controlled simultaneously for both the inverters through common control bus. The plant AC electrical system shall provide a signal to each inverter to control the frequency and phase relationship of its output during normal operations. When this signal to an inverter deviates more than one hertz from the desired 50 Hz frequency, the inverter shall transfer automatically to its internal oscillator which shall maintain inverter frequency at 50 Hz. Within 0.5%. During operation on its internal frequency signal source, an inverter shall continuously monitor the frequency of the plant auxiliary AC electrical system.

6.2.5 Upon restoration of the plant auxiliary AC electrical system to 50 Hz. operations, inverter shall automatically adjust the phase relationship between its output and the plant auxiliary AC electrical system and return to the plant auxiliary AC electrical system as its output frequency and phase relationship signal source. During operation on its internal oscillator an inverter shall inhibit transfer of the static transfer switch to the alternate source. The



automatic adjustment of the phase relationship between the inverter output and plant auxiliary AC system shall be accomplished at a controlled rate which shall not exceed one hertz per second. The inverters shall include a separate voltage distribution and voltage monitoring system for all command and interlock logic.

6.2.6 Selective protection shall be provided for each individual drive card and its associated interlock logic. The two inverters shall be designed for normal continuous parallel operation. To maintain specified output at maximum ambient temperature, inverters may be provided with cooling air fans as required. Fan cooling, if envisaged, shall be achieved with 2 x 100% cooling banks. One cooling fan bank shall be in operation while the other shall remain on standby. In case of failure of running bank / one fan, the standby bank shall start automatically. The power supply for the fans shall be tapped from the inverter output.

6.2.7 All the fuses used in inverter power and control circuits shall be fast acting semiconductor type, operating in less than 5 ms. Indications and alarms shall be provided to enable fault to be located and rectified at the earliest. Lamps to indicate fault / trouble / failure of each subgroup shall be provided on the cubicle front and lamps for each logic card shall be provided on the card itself.

6.3.0 Static Transfer Switch

6.3.1 The static transfer switches shall use SCRs and other static devices, for automatic transfer of load from the Normal source to the Alternate source. The transition shall be "make before break" in both directions. The continuous capacity of each static switch shall be equal to the full load capacity of one inverter. Maximum transfer time including sensing shall not be more than ¼ cycle. The voltage failure shall be sensed at the output of the static switch. Failure shall cause the static switch to transfer. The load from the working inverter shall be transferred to the alternate source, i.e. second inverter or auxiliary power supply source by static switches, whenever the output voltage of the inverter deviates more than +10% from nominal. However, transfer shall not be made to the alternate source on over current conditions. Transfer shall be permitted only if voltage of the alternate source is within $\pm 2\%$ of nominal.

6.3.2 The static switch shall be provided with fuses in both 'normal' and 'alternate' power source. Provision for annunciation of failure of fuse or failure of alternate source shall be made. The switch shall be provided with surge suppression networks and shall also be rated to withstand transient voltages up to 150% of rated voltage. The short time rating of the switch shall be 150% of the rated full load current for two (2) minutes.



6.4.0 Bypass Switch

Make before break type manually operated bypass switch of 100% UPS rated capacity shall be provided in the back up supply circuit to isolate static switch and inverter from its load and supply alternate power to load without interruption. Power supply to the loads is continuous during switch operations. Necessary isolators shall be provided to isolate both UPS system completely from back up supply circuit when the UPS loads are fed by back up source through bypass switch.

6.5.0 Transformer and Voltage Stabiliser

Transformers shall be provided at input and as well as output side of UPS.

The transformer shall be dry type, double wound, Class F insulated with copper conductor limiting temperature rise to class B limits, enclosed in CRCA sheet steel panel 2 mm thick. The cooling shall be by means of natural convection. Transformer connection shall also be considered, provided the connection has minimum unbalance on the primary side. The transformer shall be adequately rated for the duty involved. The actual value may be slightly increased to take care of any losses in the static voltage stabilizer.

Voltage stabilizer shall employ SMPS controlled circuitry and shall maintain the specified output voltage for 0 to 100% load, with maximum input voltage variation.

6.6.0 UPS Enclosure & Accessories

6.6.1 UPS shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm for load bearing members and 1.6 mm for non-load bearing members. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP-31. At bottom removable gland plates of at least 3 mm thick shall be provided. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

6.7.0 Metering & Protection

6.7.1 Voltage, current, frequency at input and output shall be measured either through LCD display or separate meters in UPS panel front. For remote metering of essential parameters, 4-20 mA transducer outputs shall be provided. For remote indication/ annunciation, potential free contact shall be provided along with RS485 port. LED status indications and alarm indications shall be provided on the mimic on the panel. The following protections shall be provided.

- MCCB at each input supply



- DC MCCB at Battery supply
- Filter at input
- Surge suppressor across transformer secondary
- Semiconductor fuses for SCR bridges
- HRC fuses for filter capacitors
- DC over voltage protection
- Charger input current limit
- Battery current limit
- Under voltage on input side
- Negative sequence current protection on input side
- Overload on inverter
- DC ground fault protection
- HRC fuses in control circuit
- Under voltage / Over voltage protection
- Any other protection required for safe operation of the UPS.

6.8.0 UPS AC Distribution Board

6.8.1 AC distribution board shall be metal enclosed, fixed type, suitable for indoor mounting on floor, bottom cable entry. The distribution board shall be single front having horizontal and vertical bus bars. All bus bars shall be PVC sleeved. Where specified, it shall be compartmentalized type.

6.8.2 The distribution board shall be fabricated using cold rolled sheet steel of thickness shall be 2.0 mm minimum for load bearing and 1.6 mm for other members and enclosure shall be IP 52. Earthing bus bar shall run in the bottom chamber through the length of the panel. Suitable synthetic rubber gaskets shall be provided to make boards completely dust and vermin proof. Two separate grounding pads shall be provided for each panel.

6.8.3 MCCBs shall be of triple pole construction for panel mounting, operating mechanism shall be trip free, quick make quick break type. MCCB should be current limiting type only. The MCCBs shall be provided with front operating handles & mechanical ON/OFF indicators. MCCBs shall be provided with overload thermal releases setting range of 80% to 100% of rated current and adjustable short circuit magnetic releases from 5-10 times rated current. MCCBs shall have following accessories & features:

- Shunt trip release
- Auxiliary contact set of 1 NO + 1NC
- Fault signaling contact set of 1 NO + 1NC



- Insulation shields to isolate the connection between each pole.
- Finger protection plate to prevent accidental contact.
- The compartment door shall be interlocked with handle of MCCB

6.8.4 MCCB shall be rated for 10kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCCB shall have the following:

- Over current protection
- ON/OFF Trip position indicators
- Auxiliary contact block

6.8.5 MCCB shall be rated for 10kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCCB shall have the following:

- Over current protection
- ON/OFF Trip position indicators
- Auxiliary contact block

6.9.0 Battery MCCB Box

For each Battery, MCCB box shall be provided for maintenance isolation and for short circuit protection. The MCCB box shall comprise MCCB sized for the Battery capacity. It shall be enclosed in sheet steel enclosure of at least 2 mm, having IP:54 degree of protection. The MCCB box shall be wall mounted type located in Battery room.

MCCB shall be Double Pole type. It shall be quick make, quick break, and independent manual type with trip free feature. It shall have the following:

- Short circuit release
- ON/OFF Trip position indicators
- Test trip push button
- Voltage rating shall be suitable for 500 volts AC/DC.

6.10.0 Discharge Resistor

Discharge resistor shall be provided for testing the Battery. The discharge resistor shall be adequately sized for charge - discharge cycle testing of different type & rating of batteries with necessary tapping. It shall be enclosed in sheet steel enclosure of at least 3 mm, having IP:31 degree of protection. Resistor shall be of punched stainless steel. Temperature rise shall be limited to 150deg Cover 50deg C ambient. The Discharge resistor shall be mounted on trolley with bi-directional wheels.



7.0 PAINTING

The fabricated parts shall undergo a treatment of degreasing, pickling and two coats of primer before being given the epoxy finish. Two coats of final paint shall be applied. The external and internal surface of the board shall be powder coated epoxy finish of gray shade RAL 7032. The final thickness of paint film on steel shall not be less than 85 microns.

8.0 TESTING & INSPECTION

Equipment offered shall be of type tested and proven type. Type test certificates for tests conducted earlier on similar ratings shall be furnished. The test reports shall not be older than 5 years from the date of bid. The Owner shall review the type test certificates furnished by the bidder at the contract stage. Routine tests, functional tests and system tests shall be carried out as per applicable standards. Copies of certified reports of all tests carried out at the works shall be furnished.



H. EARTHING & LIGHTNING PROTECTION SYSTEM

1.0 INTENT OF SPECIFICATION

This section covers the requirements of Earthing & Lightning protection system. The scope shall include the following:

- Buried earth mat for the Desalination plant system.
- Embedded earth mat in the concrete floor of buildings.
- Equipment enclosure earthing for all electrical equipment.
- Earthing of all metallic structures including cable racks
- Electronic earthing for all PLC/electronic equipment
- Lightning protection for the plant

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and /or supplemented by this specification.

- | | | |
|--------------|---|--|
| a) BS 7430 | : | Code of practice for earthing |
| b) BS 6651 | : | Code of practice for protection of structures against lightning |
| c) IEEE 142 | : | IEEE recommended practice for grounding of industrial and commercial power systems |
| d) IEEE 80 | : | IEEE guide for safety in AC substation grounding |
| e) IEEE 665 | : | Standard for generating station grounding |
| f) IEC 62305 | : | Protection against lightning |

3.0 TECHNICAL REQUIREMENTS

3.1 Earthing System

3.1.1 Bidder shall provide earth mat of spacing as per the obtained size from earthing calculations below desalination plant. Suitable number of earth electrodes shall be provided. Perimeter earthing shall be provided around the building. The above grade earthing works including connection of equipment shall also be in bidder's scope. Earthing conductor for ground mat shall be minimum of 32 mm dia. GI Pipe with adequate corrosion protection.

3.1.2 The earthing system shall meet the following requirements:

- Ensure adequate earth fault current for operation of earth fault protection.



- Earthing conductors and connections shall withstand earth fault current for the duration of the fault for 1 sec.
- 3.1.3 The Galvanized steel rod earth grid shall be designed to withstand 25 years of corrosion. Highest Corrosion rate shall be arrived considering soil resistivity at site.
- 3.1.4 Buried earthing conductors shall have at least 600mm of earth cover unless stated otherwise.
- 3.1.5 Wherever earthing conductor crosses cable trenches, pipes, road, drain, tunnels, other crossing, etc., it shall be laid minimum 600mm below them and shall be circumvented in case it fouls with equipment / structure foundations.
- 3.1.6 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.
- 3.1.7 Earthing conductors crossing the road shall be laid 600mm below road or at greater depth to suit site conditions.
- 3.1.8 Earthing pads shall be provided for the apparatus / equipment at an accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices.
- 3.1.9 Steel / RCC structures & columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of handrails and metallic stairs.
- 3.1.10 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval not more than 10 mtrs. Apart from intermediate connections, beginning & end points shall also be connected to earthing system.
- 3.1.11 Metallic structures, conduits etc. shall not be used as earth continuity conductor.
- 3.1.12 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.



- 3.1.13 Flexible earthing connectors shall be provided for moving parts, Doors, etc.
- 3.1.14 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust, or dirt. Two bolts shall be provided for making earth connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint / compound.
- 3.1.15 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protection, the welds shall be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.
- 3.1.16 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 3.1.17 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 3.1.18 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 3.1.19 Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end.
- 3.1.20 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to at least to two rod earth electrode which in turn, shall be connected to station earthing grid.
- 3.1.21 For electronic equipment such as PLC, chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 25 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 3500mm depth. The pit shall be effective in all weather conditions and offer low resistance.
- 3.1.22 Minimum Size of the earthing conductor shall be as follows:



S. No	Equipment	Earth conductor size
1.	Earth conductor above ground level & in built-up trenches	240 sqmm Copper Rod
2.	415V PCC, MCC,DCDB & MLDB	95 sqmm copper conductor
3.	Control panel, control desk & Cable trays	35 sqmm copper conductor
4.	Push button station / Junction Box	35 sqmm copper conductor
5.	Columns, structures, and busduct enclosures	240 sqmm copper conductor
6.	Lighting Panel	95 sqmm copper conductor
7.	above 55 kW	70 sqmm copper conductor
8.	above 22 kW & up to 55 kW	35 sqmm copper conductor
9.	above 5.5 kW & up to 22 kW	25 sqmm copper
10.	5.5 kW & below	16 sqmm copper conductor

3.1.23 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture, and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

3.1.24 Earth pits shall be located avoiding interference with road, building foundation, column, equipment foundation etc. The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically. Proper symmetry and distance between earth pits shall be maintained as per applicable standards and procedures. Treated earth pits shall conform to relevant standard. Minimum 4 nos Maintenance free earth pits with back filling chemical compound shall be provide for main earth grid of desalination plant. Inside dimension of the maintenance free earth pit chamber shall not be less than 600x600 mm. it shall be brick work / precast of M35 Grade RCC with base of 75mm thick PCC for complete chamber and plaster & exterior paint over exposed surfaces. Top cover of Earth Pit shall be of medium duty cast iron with frame (600x600mm) with suitable hinged type lifting arrangement of reputed make (HDPE/Pre-cast covers are not permitted). Further minimum one number Maintenance free earth pit shall be provided for junction box / local panel of each Borewell.



- 3.1.25 Construction of trench for earthing conductor shall include excavation, laying of conductor, back filling compound and compacting. Back filling compound material to be placed over buried conductors shall be of approved make. Back filling compound shall be placed all-around of earth electrode with pit dia of 150mm or pit dia as per directive of OEM. Minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench / foundation / underground pipes at crossings.
- 3.1.26 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Equipment required for testing shall be furnished by Contractor.
- 3.1.27 Electronic panels and equipment shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrode.
- 3.1.28 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Steel RCC columns, metallic stairs, handrails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing.
- 3.1.29 Metallic sheaths, screens, and armour of all multi core cables shall be earthed at both ends.
- 3.1.30 For cable trays, a separate ground conductor shall run along the entire length of cable tray and shall be suitably clamped on each cable tray at periodic intervals. Each continuous laid out lengths of cable tray shall be earthed at minimum two places by G.I. flats to main earthing system at both ends, the distance between earthing points shall not exceed 30 meters. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.
- 3.1.31 All ground conductor connections shall be made by electric arc welding, and all equipment earth connections shall be made by bolting with the earthing pads through flexible insulated cable leads. Ground connections shall be made from nearest available station ground grid risers. Suitable earth risers approved by Owner shall be provided above finished floor/ground level if the equipment is not available at the time of laying of main earth conductor.
- 3.1.32 Resistance of the joint shall not be more than the resistance of the equivalent length of conductor. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound.



3.1.33 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated. Earthing conductor's crossings the road shall be installed at 1000 mm depth and where adequate earth coverage is not provided it shall be installed in HUME pipes. Earthing conductors embedded in the concrete floor of the building shall have approximately 50mm concrete cover.

3.1.34 A minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench/foundation at crossings. Wherever earthing conductor crosses on runs at less than 300mm distance along metallic structures such as water pipelines, steel reinforcement in concrete, it shall be bonded to the same.

3.1.35 Earthing conductors along their run-on columns, walls, etc. shall be supported by suitable welding/cleating at interval of 1000mm.

3.1.36 Earth pit shall be constructed as per approved standards & installation notes. Copper Bonded Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 6000mm. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building or any structure.

3.1.37 Earthing of cabling system

- Armour of the single core LV cables shall be earthed only at one end of cable.
- Armour of other cables shall be earthed at both ends of cable.
- Screen of LT power cables shall be earthed at one end only.
- Screen of C&I screened control cables shall be earthed at one end.
- Screen of electronic earthing system cables shall be earthed as per the requirements to be furnished to the Contractor during contract stage.

3.1.38 Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600mm deep and 600mm wide, laying of conductor at 600mm depth, brazing / welding / cad welding, if required, of main grid conductor, joints as well as risers of length above ground at required locations and then backfilling. Backfilling chemical compound to be placed over buried conductor. Backfill shall be placed in layers of 150mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. Back filling of earth pit shall only be done using back filling chemical compound only.

3.1.39 Installation of earth pit shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on pipe / rod / plate electrodes in test pits and connecting to main earth grid conductors.



- 3.1.40 After completion of grounding system installation, the measurement of ground resistance shall be performed by the Contractor. Before measurement, the overhead ground wires shall be disconnected. The method of measurement shall be as per relevant standards / codes. The ground resistance of grounding system shall be not more than 5 ohm.
- 3.1.41 All bolt joints must be protected from corrosion by applying suitable paste / grease / petroleum jelly etc. at the time of installation. Same shall be included in the notes of all relevant drawings. All metallic hardware such as nuts, bolts, screws, washers etc. shall be of SS304 grade only.
- 3.1.42 SS 304 bolts, nuts with plain and spring washer (on both sides) shall be provided for petty clamp of earth electrode.
- 3.1.43 Each earth pit shall have permanent identification with engraved plate fixed on OR near to Earth pit. The engraving shall have sufficient depth and letter size shall be not less than 25 mm. Material of engraving plate may be aluminum / aluminum alloy / SS 304.
- 3.1.44 Date of testing, value of earth resistance measured and next date of testing shall be provided on each earth pit either by painting or by weather proof vinyl sticker. Letter size shall be not less than 50 mm.
- 3.1.45 Pre galvanized GS Strip with GI coating shall be as mentioned in tender specifications. Main earth grid GS earthing rod shall be extended up to building (at least 500mm above NGL) for connecting each room / building earth grid with the main earth grid at extreme Two points

4.0 LIGHTNING PROTECTION SYSTEM

- 4.1 All areas of the WTP backwash handling system shall be provided with lightning protection as per IEC 62305. The lightning protection system for buildings shall consist of Galvanized Iron horizontal air terminations, steel rod vertical air terminations, down conductors, test link and earth electrodes.
- 4.2 Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.



- 4.3 For Lightning protection, material & sizes shall be selected based on the lightning protection system calculations.
- 4.4 The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within 200 mm. vicinity shall be bonded to the lightning protection system.
- 4.5 All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.
- 4.6 Lightning conductor when used above ground level and shall be connected through test link with earth electrode/earthing system. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.
- 4.7 Each down conductor shall be provided with a test link at 1500 mm above ground level for testing, but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of welded type. Dedicated Earth pit (Earth pit specification as mentioned in earthing section) shall be provided for each down conductor.
- 4.8 Down conductors shall be cleated on outer side of building wall/ welded to outside building columns at 1000mm interval.
- 4.9 Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of MCC/insulating compound shall be used for conductor fixing at an interval of 1500mm.
- 4.10 Thickness of galvanizing shall be at least 110 micron considering site condition
- 4.11 Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening, and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.



- 4.12 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Resistance of individual earth electrode shall be measured after disconnecting it from the grid. Tests shall be carried out as per IS: 3043 for earthing installation including the following:
- a) Earth continuity checks
 - b) Earth resistance of the complete system, sub-system, and earth pits



I. AUTOMATIC POWER FACTOR CORRECTION SYSTEM

1.0 INTENT OF SPECIFICATION

This section covers the requirements automatic power factor correction system

2.0 CODES AND STANDARDS

The design, manufacture and testing of Automatic Power Factor Correction with shunt capacitor bank shall comply with the latest issue of the following standard: -

- IS – 2834
- IS 13340-1993
- IS 13341-1992
- IEC 60831-1+2

3.0 GENERAL REQUIREMENTS

- 3.1. The capacitors shall be mounted on a separate rack inside the panel.
- 3.2. Adequate forced cooling, if required, shall be provided for satisfactory operation of the complete system under the specified site conditions.
- 3.3. Necessary control & power wiring and accessories shall be provided including facility to switch 'ON' individual capacitor feeders manually. A time delay provision shall be made to avoid repeated operation of any feeder in short time.
- 3.4. Contactors shall be selected to suit the capacitor rating, and each feeder shall be provided with independent 'ON' & OFF' PB's and 'ON' indication lamp. Ammeter, Voltmeter and PF meter shall be provided.
- 3.5. The Contractor shall be fully and finally responsible for proper erection and safe and satisfactory operation of the equipment under his scope of work to the complete satisfaction of the Owner. Equipment and material, which are wrongly installed, shall be removed and re-installed to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner.

4.0 TECHNICAL REQUIREMENTS

4.1 Power Capacitors

- 4.1.1 Power Factor Correction Capacitor shall be of low loss, dry-filled with flame proofed mineral



agent, non-gas, non-PCB-based, non-toxic and Metallised Polypropylene with Self-Healing properties in compliance with latest IS/IEC.

- 4.1.2 The Over-Voltage Withstand Capability of Capacitors shall be in accordance with VDE 0560, part 41. The Capacitors shall be selected considering the voltage increase due to Normal System over voltage of 10%.
- 4.1.3 The Capacitor shall be designed for an ambient Temperature of – 40 Deg. C to +60 Deg C. Energy losses in each Capacitor unit shall be less than 0.2 watts per kVAR. The capacitor shall be designed with a capacitance tolerance of +/-5%. The capacitor shall have maximum overloading capability of 2 times the rated current.
- 4.1.4 The capacitor unit shall be provided with internal discharge resistor unit and it shall be reduced the terminal voltage less than within 60 seconds after the disconnection of power supply. Interconnection between capacitor units shall be provided through tinned copper busbar links or copper cable.
- 4.1.5 The Capacitor shall be able to withstand Inrush currents of up to 350 times the rated current to ensure safe switching operations and a life expectancy of not less than 100,000 operating Hours.
- 4.1.6 The Capacitor shall be of 3-Phase Symmetric construction type, corrosion-resistant, deep-drawn Aluminium casing-make and hermetically sealed to ensure excellent heat dissipation and constant capacitance over its full service life.
- 4.1.7 The design of the capacitor shall be based on stacked assembled winding elements to improve cooling of the active element, reduce hot spot temperature and to reduce the risk of device breakdown.
- 4.1.8 The capacitor unit shall incorporate a three-phase overpressure tear-off fuse system to prevent capacitor rupture at the end of service life or due to inadmissible electrical or thermal overloads.

4.2 Capacitor Duty Contactor

- 4.2.1 The Switching Device being the only moving Component in the total system necessitates careful selection for this application to ensure longer life for these Contactors. Suitable Rating of the Device shall be selected depending on the Voltage & Current Rating of the Capacitor Circuitry considering switching phenomena of Capacitor Circuitry. The Contactor shall be of low bouncing with Damping Resistor associated with it to limit the inrush current in the event of closing the circuit.

4.3 Power Factor Controller

- 4.3.1 Relay shall have four quadrant sensing & measurement, and dual Target Power Factor



setting.

- 4.3.2 Relay shall sense the Voltage Harmonics continuously and shall have alarm and tripping features for pre-selectable harmonic limits.
- 4.3.3 Relay shall display 5th, 7th, 11th & 13th Voltage Harmonics in % along with Instantaneous Power Factor, Active Current, Reactive Current, Apparent Current etc.
- 4.3.4 Relay shall have proper sensing accuracy to operate capacitors up to 0.4% of primary current.
- 4.3.5 Relay shall have Kinked Control Curve characteristics for Protection against light load over compensation.
- 4.3.6 Relay shall have Automatic Identification of Threshold Current, Connected Capacitor Stages & Switching Sequences.
- 4.3.7 Relay shall have automatic identification of capacitor stages, optimization of switching delay, continuous monitoring of the faulty stages, Zero Voltage & Zero current tripping along with Alarms.
- 4.3.8 Relay shall be capable of switching the Capacitors in cyclic manner
Relay shall have alarm features for high harmonics, over current, under compensation, fault in voltage / current circuits, capacitor stages, high switching operations (Reset table switching counter) etc.
- 4.3.9 Relay shall have Manual & Automatic Operational selection.



J. INSTALLATION

1.0 INTENT OF SPECIFICATION

This section covers the requirements of Electrical installation. This shall also cover supply and installation of following items:

- Rubber mats for switchboards
- Caution boards
- Sand buckets
- First aid box
- Sheet steel cover for the exposed electrical equipment/cable shaft/trench etc.
- Cable route markers & Cable joint markers
- Shock hazard chart
- Erection hardware

2.0 CODES AND STANDARDS

Installation of cabling work shall comply with the latest edition of following standards, rules, regulations, and acts.

- BS:6651 : Code of practice for protection of structures against lightning.
- BS:7430 : Earthing.
- BS:7671 : Requirements for electrical installations.
- IEC:62305 : Protection against lightning.
- IEC:60364-5-54 : Electrical installations of buildings-Earthing arrangements and protective conductors.
- IEC 60034 : Rotating Electrical Machines (tests)
- BS EN 50110 : Operation of electrical installations.

3.0 GENERAL REQUIREMENTS

- 3.1. The work shall be carried out in the best workman like manner in conformity with the latest editions / amendments of relevant specifications / codes / standards / regulations.
- 3.2. Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, erecting, testing and commissioning of all items / equipment and care shall be exercised in handling to avoid distortion to stationary structures, marring to finish, or damaging of delicate instruments or other electrical parts.



- 3.3. All the equipment covered under this specification shall be installed in neat, professional manner such that the structures and equipment are level, plumb, squat, properly aligned and oriented. Clearance around electrical panels / equipment shall be as per relevant standards.
- 3.4. The Contractor shall be fully and finally responsible for proper erection and safe and satisfactory operation of the equipment under his scope of work to the complete satisfaction of the Owner. Equipment and material, which are wrongly installed, shall be removed and re-installed to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner.
- 3.5. The installation shall be carried out in such a manner as to provide access to other equipment installed. The Contractor shall restore floor / wall chipping, road cuttings and other such works done including replacement of equipment removed back to its place and make good damages done to the original.
- 3.6. The Contractor shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished work where required shall be suitably covered to keep it clean and free from defacement or injury. Contractor shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to Contract.
- 3.7. All safety rules and codes as applicable to work shall be followed without exception. All safety appliance and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Contractor for his personnel.
- 3.8. The Contractor shall provide guards and prominently display caution notices if access to any equipment / area is considered unsafe and hazardous. In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.
- 3.9. The Contractor shall have a separate cleaning gang to clean all equipment under erection as well as the work area and the project site at regular intervals to the satisfaction of Owner. In case this is not done, the Owner will have the right to carry out the cleaning operation and any expenditure incurred in this regard will be to the Contractor account.
- 3.10. The Contractor shall ensure that instruments and gauges to be used for testing and inspection have valid calibration and the accuracy can be traced to National Standards.



- 3.11. It shall be the Contractor's responsibility to obtain approval from local statutory authorities including Electrical Inspector / CEA, wherever applicable, for carrying out any work or for installation carried out which comes under the purview of such authorities. All such documents and certificates shall be handed over to Owner which then shall be property of the Owner.
- 3.12. The installation shall be carried out only by electrical Contractor, holding a valid license, issued by relevant authorities for carrying out installation work of the voltage classes involved, under the direct supervision of a person holding valid certificates of competency for the same voltage classes, issued or recognized by the state Government.
- 3.13. The installation shall have to be approved by statutory government authorities like Electrical Inspector, Factory Inspector, Insurance Officials etc. It shall be the responsibilities of Contractor to prepare and submit all necessary drawings, calculations and test certificates to electrical inspectorate and obtain approval prior to installation and commissioning work and arrange inspection by them after installation. After inspection, any modification in the equipment of installation that may be demanded by them shall have to be carried out by the Contractor at no extra cost to the Owner. The Contractor shall take all necessary steps to enable the Owner to get the installation approved by the above authorities and shall render all necessary assistance to the Owner in the matter.
- 3.14. Handling of equipment shall be done strictly as per manufacturer's / supplier's instructions / instruction manual. Handling equipment, sling ropes etc. shall be tested periodically before erection for strength. The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.
- 3.15. All boards shall be made completely vermin-proof.
- 3.16. Contractor shall take utmost care in holding instruments, relays and other delicate mechanisms wherever these are supplied separately. They shall be installed only after the associated panels have been erected and aligned. The packing materials employed for safe transit of these shall be removed after ensuring that panel have been completely installed and no further movement of the same are necessary. Any damage shall be immediately reported to Owner.
- 3.17. Equipment furnished with finished coats of paint shall be touched up by Contractor if their surface is scratched or marred while handling.



- 3.18. After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards / panels and correctness of all equipment in every respect.
- 3.19. The cable opening and cables entries for cables terminating to the panels shall be sealed with approved fire sealing materials.
- 3.20. All doors of all switchgears & cabinets, terminal boxes etc. shall be provided with locking facility. Three sets of keys shall be handed over to the Owner after installation.
- 3.21. The Contractor shall make his own arrangement for moving/lifting all the equipment/items into the respective buildings/erection sites. No part of the structure shall be utilized to lift or erect any equipment without prior permission of the Owner.
- 3.22. The installation shall be carried out in such a manner as to provide access to other equipment installed. The Contractor shall restore floor / wall chipping, road cuttings & other such works done including replacement of equipment.
- 3.23. Cable installation shall be properly coordinated at site with other services and wherever necessary suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures, equipment, utilities and services Any such adjustment shall be done with the approval of Owner.

4.0 CABLING CONCEPT

- 4.1 In the plant building, switchgear rooms etc., power and control cables shall be laid on GS cable trays installed in GS cable trays support positioned in the RCC cable trenches or false flooring level & overhead trays or along building and structures as the case may be. Short cable runs in auxiliary plant areas local to equipment shall be laid in floor slits up to near the equipment.
- 4.2 In cable trenches, pipe racks/ cable racks, overhead routes, cables shall be laid in cable trays only. Fewer cables installed along buildings, structures, ceilings, walls, etc., which are required to be protected against mechanical damage, shall be taken in GI conduits. Fill factor shall be not be more than 40%.



- 4.3 GI Conduits shall also be used for flameproof installations, wherever required, with sealing at both ends.
- 4.4 Entry of cables from trenches into buildings shall be by means of GI Pipes. Trenches / duct banks/ embedded conduits shall enter buildings as per approved installation notes. All such entries shall be sealed against water ingress after completion of cable laying. The method of sealing shall not be deleterious to the cables and shall be to the approval of Owner. During cabling work, all such pits as are meant for cabling shall be kept in dry condition by use of means such as portable sump pumps specially during rainy season. Suitable numbers of such pumps shall be deployed to ensure no water collection/ retention in cable pits / indoor trenches etc.
- 4.5 Cables laid exposed in racks/trays and routed from cable tray etc to individual drive / control devices etc shall be taken in embedded/exposed/surface-grouted rigid GI conduits / rigid PVC Conduits and / or flexible conduits as specified in the approved installation notes, unless directly terminated to the equipment in the panels located above trenches, tunnels or basement.
- 4.6 All cables routed along walls or in equipment rooms shall be protected by means of laying them through G.I. pipes.
- 4.7 Where direct heat radiation from equipment/pipes exists, heat isolating barriers for cabling system shall be adopted.
- 4.8 Wherever cables are to be laid below roads, the same shall be taken through ducts buried at a suitable depth. Provisions of relevant IEC standards shall be followed for cables buried directly in ground / duct.
- 4.9 At certain places where hazardous fumes/gases may cause fire to the cables, cable trenches after installation of cables may be sand filled.
- 4.10 In corrosive atmosphere, PVC conduits shall be used for cables. Metallic pipes / conduits shall not be used in corrosive areas.
- 4.11 Cable routes shall be segregated unit wise, to the extent possible. Similarly, cables for the standby drives shall preferably be taken through the alternative route.



- 4.12 Complete cable tray support structure after installation shall be inspected for straightness, accuracy, use of proper sizes & compliance to drawings.
- 4.13 Complete cable tray & accessory installation work shall be inspected/tested for proper alignment, levelling (by use of plumb lines), use of proper accessories, provision of proper bending radius at bend for site fabricated accessories and high-quality workmanship.
- 4.14 Cable trays shall be ladder type for power and electrical control cables, while perforated type cable trays shall be used for instrumentation and control cables. However, in vertical cable tray risers, all trays shall be ladder type.
- 4.15 Screened control cables of small cross-sectional area shall be terminated by means of Maxi-Termi termination system.
- 4.16 Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per the control schemes and other related documents.
- 4.17 Flexible conduits shall be used between fixed conduits and equipment terminal boxes, where vibration is anticipated.
- 4.18 Junction boxes of SS-304 grade material with 1.5mm sheet thickness shall be installed so that they are level, plumb & properly aligned and present a pleasing appearance. Boxes shall be adequately supported by means of proper supporting arrangement to Owner's approval. The Contractor shall perform all drilling, cutting, welding & bolting required for attachment of supports.
- 4.19 The Contractor shall seal off all the floor and wall openings after installation of conduits/pipes/trays for cabling/earthing materials.
- 4.20 All welding work shall be carried out by electric arc welding method only with appropriate size of welding electrodes to ensure sufficient welding strength.
- 4.21 Flexible conduits shall be used for the final connection between rigid conduits & motors, only for vibrating equipment or equipment requiring regular removal.
- 4.22 Wherever it is possible for water or liquids to enter conduits, sloping of conduit runs and drainage of liquids accumulated shall be ensured.



- 4.23 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and grounded, preferably with grounding bushings or grounding clamps.
- 4.24 Minimum bending radius for conduits shall be 10 times the external diameter of the conduit.
- 4.25 All conduits shall be permanently identified at each end with the conduit number assigned to it as per the applicable document or drawing.
- 4.26 Pull boxes shall be installed between termination points wherever required to facilitate cable out at a maximum interval of 30metres.
- 4.27 Conduits shall be firmly fastened within 900mm of each junction box, cabinet, or fitting. Conduits shall be supported at least every 2000mm.

5.0 CABLE TRAY AND SUPPORT SYSTEM INSTALLATION

- 5.1. Cable trays shall be bolted to tray mounting GS supports with a minimum clearance of 300mm between cable tray tiers.
- 5.2. Cable trays shall be supported at an interval of 1500mm for all horizontal runs. For vertical cable risers/shafts cables will be supported at every 1000 mm interval.
- 5.3. Support system shall be so designed that it is able to withstand weight of the cable trays, Weight of the cables (75 Kg/meter run of each cable tray), Concentrated load of 75 Kg between every support span without any permanent deflection. Factors of safety of at least 1.5 shall be considered.
- 5.4. Cable tray supports shall be of 'Unistrut' type, which shall be installed at site by bolts. Fixing of tray supports by welding is not allowed. Cable tray supports structure shall be bolted to the steel structure by clamping and to concrete structures using anchor fasteners.
- 5.5. All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 60mm. For long lengths of trays, the identification shall be painted at every 10 meters. Risers shall additionally be painted / stenciled with identification numbers at every floor.



- 5.6. Tray covers shall be provided for overhead cable trays on topmost tier. The cable risers or vertical raceways shall also be covered by cable tray covers up to 1.5 meters from respective floor for mechanical protection. The sheet cover shall be of removable type.
- 5.7. At least 300 mm spacing shall be maintained between top of the trays and beams/piping etc. Solid covers shall be provided for outdoor trays, top tray of horizontal tray runs located under grating floor or insulated piping, and for all trays routed in areas where oil might enter or accumulate.
- 5.8. Contractor shall install galvanized GS sheet covers over cable shafts. The width of the covers shall be same as that suitable for cable trays. Bolting shall be done to fasten covers to the cable trays, elbows, reducers, tees, crosses etc.

6.0 CABLE INSTALLATION

- 6.1. Cable installation shall be carried out as per relevant IEC and other applicable standards.
- 6.2. Power and control cables shall be laid on separate tiers. Separate cable trays shall be used for the following:
 - LT Power Cables
 - Control Cables
 - Instrumentation/communication cables
- 6.3. Multicore cables shall be laid in touching formation. Power and control cables shall be securely fixed to trays /supports with self-locking type nylon cable strap with de-interlocking facility at every 5-meter interval for horizontal run and cables laid in vertical run of trays shall be securely fixed to trays/supports by galvanised steel clamps at every one metre interval. All power cables should be clamped individually. In general power and control cables shall be laid in ladder type trays & instrumentation cables shall be laid on perforated type trays respectively.
- 6.4. Bending radii for cables shall be as per manufacturer's recommendations.
- 6.5. Where cables crossroads tracks, the cables shall be laid in HDPE pipes embedded in ground with a minimum cover of 1 metre or with RCC covering for lower depth.
- 6.6. In each cable run some extra length shall be kept at suitable point to enable one straight through joints to be made, should the cable develop fault at a later stage. Control cable



termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

- 6.7. For Directly Buried cables, construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Before the cables are placed, the excavated portion shall be filled with a layer of sand. This sand layer shall be levelled, and the cables laid over it. The cables shall then be covered with 150 mm sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering with 70 mm thick bricks shall then be provided on top. The remaining portion of the excavated trench shall then be back filled with soil, rammed, and levelled.
- 6.8. RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 75mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.
- 6.9. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 30 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centres, control, and relay panels etc. where several cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2mm thick aluminium with number punched on it and securely attached to the cable GI wire.
- 6.10. Where a cable route crosses a permanent road shall be drawn through hume pipes or G.I. pipes. Pipes should be laid in a straight configuration. Filling criteria in any pipe shall not be more than 40%.
- 6.11. Conduits shall be used for routing of cables (power / control) from cable trays to equipment/ junction boxes. Pipe sleeves shall be used for routing of cables between floors, road crossing, entry/exit from outside of building etc. All conduits/pipe shall have their ends closed by caps



till the cables are pulled. After the cables are pulled, the ends shall be sealed by suitable sealing compound having fire withstand capability.

6.12. Each cable and cable tray shall be tagged with numbers. Cables and conduits shall be tagged at their entrance, at each bend, at every 30 m and exit from any equipment, junction box. The tags shall be of aluminium or other approved means with the number punched on it and securely attached to the cable. The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription "Cable-Joint" and "Cable Number".

6.13. Cable Termination and Jointing

6.13.1. All cable entries in the equipment shall be sealed by cable glands.

6.13.2. Adequate length of cables shall be pulled inside the switchboards, control panels, terminal boxes etc to permit neat termination of each core / conductor.

6.13.3. Power cable terminations shall be carried out in a manner such as to avoid strain on the terminals by providing suitable clamps near the terminals.

6.13.4. Control cable cores entering switchboard or control panels shall be neatly bunched and strapped with PVC perforated tapes / nylon ties and suitably supported to keep them in position at the terminal block. All spare cores shall be connected to spare terminals, wherever possible. If spare terminals are not available, spare cores shall be neatly dressed and suitably taped at both ends.

6.13.5. Screened control cables of small cross-sectional area, e.g., 0.5mm², shall be terminated by means of maxi-termi termination system. Contractor shall ensure the availability of all tools, tackles and accessories such as maxi-termi guns, clips, wire etc. required for the termination of small cross section screened control cables by this method. Compressed air supply for maxi-termi guns shall also be the responsibility of Contractor.

6.13.6. Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per control schemes and other related documents.

6.13.7. Fiber optic termination and splicing equipment shall be used for cutting, finishing and joining fiber optic cables. An optical fiber tool shall be used to slice into the cable's outer coating and unpack the fibers without damaging them. Fiber optic cleaners, cleaning chemicals or solvents and cleaner dispensers shall be used for preparation of the cut and polished joint



or splice. Fiber optic cables shall be terminated by using connectors to couple the cable to network devices. Fiber optic connectors shall be specifically designed to limit light loss and provide a secure connection to a device. The fiber optic termination connectors shall have a bayonet mount and a cylindrical ferrule to hold the fiber in place.

7.0 TESTING AND COMMISSIONING

- 7.1. The Contractor shall take full responsibility of testing at erection, pre-commissioning and commissioning stages of all the equipment / system being installed by him. The Contractor shall submit to the Owner a checklist for testing and commissioning and the activities shall be carried out in accordance with the checklist. The Contractor shall carry out the commissioning tests and checks after erection at site as per applicable standards and as recommended by manufacturers.
- 7.2. On completion of erection work, the Contractor shall request the Owner for inspection and test. The Owner shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor. The installation shall be then tested and commissioned in the presence of the Owner and put on trial run for stipulated contract period.
- 7.3. The Contractor shall arrange for inspection of his installation work by Electrical Inspector and shall obtain necessary approval certificate for his installation work and charging. Any modification work required by Electrical Inspector must be undertaken by the Contractor at his own cost. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning, and trial run shall be carried out by the Contractor without any extra cost.
- 7.4. Following successful inspection and testing, all the equipment shall be commissioned and put on trial run in a manner mutually agreed upon based on the commissioning schedule.
- 7.5. The Contractor shall have to bring all testing equipment and instruments in sufficient numbers to carry out the job simultaneously in more than one area. Tests shall be conducted by qualified and experienced personnel. Valid calibration certificates for the testing equipment shall be produced.
- 7.6. All documents / records regarding test data and all other measured values shall be submitted to Owner for approval and subsequent record and reference. The results of all tests shall



conform to the specification requirements as well as any specific performance data guaranteed during finalization of Contract.

- 7.7. All checks and tests as per manufacturer's drawings / manuals, relevant codes of installation and commissioning checklists for various electrical equipment such as transformers, breakers, motors, switchgear, relays, meters etc. shall be carried out.
- 7.8. The Contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear / panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal AC voltage to the circuits and operating the equipment for functional checking of all control circuits, e.g., closing, tripping, control interlock, supervision circuits, alarm circuits etc. All connections in the switchgear shall be tested from point to point for possible earth or phase faults.
- 7.9. Contractor shall submit specified copies of site testing procedures, test formats along with details of site test instruments proposed to be deployed at site along with respective valid calibration certificates, six weeks prior to commencement of site testing, for approval by Owner. Only procedures and test formats approved by Owner shall be used for site testing. After completion of commissioning of all equipment and prior to handing over, six sets of such signed test data in the agreed / approved formats shall be furnished prior to issue of provisional acceptance of the equipment / installation.
- 7.10. The testing of all electrical equipment as well as the system shall be carried out at site to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards as well as accepted codes of practice.
- 7.11. All tests shall be carried out by the Contractor using his own instruments, testing equipment as well as qualified testing personnel.
- 7.12. The results of all tests shall conform to the specification requirements as well as any specific performance data guaranteed during finalization of the Contract.
- 7.13. At site, all equipment shall be energized only after certification by the personnel performing the test that the equipment is ready for energizing and with concurrence of the Owner.



- 7.14. The various commissioning checks / tests to be carried out on the various equipment shall be in accordance with applicable standards and equipment supplier's recommendation.

8.0 SAFETY REQUIREMENTS

- 8.1. Provisions of IEC rules in respect of various safety requirements shall be complied with.
- 8.2. All practical steps shall be taken to prevent operating the earth moving, lifting, and housing machinery in dangerous proximity to a live overhead power line.
- 8.3. Barricades or barriers shall be installed to prevent accidental contact with energized lines or equipment. Where appropriate, signs indicating the hazard shall be pasted near the barricade or barrier.
- 8.4. Rubber gloves and insulated shoes shall invariably be worn in all cases while operating gang operating switches controlling high tension lines and equipment where accidental contact of operating personnel with live parts are likely. While working near live lines and equipment and working on live low-tension lines and equipment, gloves shall be worn.
- 8.5. Safety belts shall invariably be used in all cases while working on overhead systems like lines, bus bars, substation equipment etc.
- 8.6. Tested Electrical Insulating mats shall be kept in front as well as back of operating panels / switches etc. They shall be checked for condition periodically and replaced as necessary. Voltage grade, IS mark, manufacture name and year etc, shall be embossed on Electrical insulating mats as per statutory requirements.
- 8.7. First aid box shall be maintained. These shall be checked periodically and refilled, or items replaced as necessary.
- 8.8. Chart for providing relief and treatment of person electrocuted shall be displayed prominently at suitable places in the substation. These shall be checked for condition periodically and replaced as and when necessary.
- 8.9. Firefighting equipment such as fire buckets filled with sand and fire extinguishers for both electrical and oil fires shall be maintained and kept at easily accessible place in switchgear room.



- 8.10. The Contractor shall supply and install all danger plates as per relevant IEC standards. The danger plates shall be written in English, Hindi and local language and shall be provided as required for all electrical equipment. Danger Boards, Respiratory charts, drawings, evacuation arrangement, safety charts, etc. shall be provided in all panel / MCC room as per statutory requirements.
- 8.11. All safety appliances and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Contractor for his personnel.



K. ILLUMINATION SYSTEM

1.0 INTENT OF SPECIFICATION

This specification covers the requirements of the Illumination system.

The list of major items shall include the following:

- Lighting fixtures
- Lighting distribution boards
- Receptacles
- Switchboxes
- Junction boxes
- FRPVC Conduits of medium duty minimum 25mm dia.
- FRLSH copper Wires of minimum size 2.5sqmm and above

2.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant Indian Standards, IEC publications and other standards as listed, except where modified and / or supplemented by this specification.

The design and testing shall follow the following standards.

- OISD-137 Inspection of Electrical Equipment
- OISD-149 Design aspects for safety in electrical systems
- IS: 10322 Luminaires: Part 1 General requirements
- IS/IEC 60079 -1 Equipment Protection by Flameproof Enclosures "d"
- IS: 8224 Electric Lighting fittings for Div. 2 areas.
- IS: 9583 Emergency lighting units.
- IS: 10322 Specification for Luminaires
- IS: 732 Electrical wiring installation (system voltage not exceeding 650V).
- IS: 12640 Residual Circuit operated Circuit breakers.
- IS/IEC:60898-1 Miniature circuit breakers.
- IEC: 60309-1 Plugs, socket-outlets, and couplers for industrial purposes
- IS/IEC 60529 Degrees of protection provided by enclosures (IP code)
- IS:694 PVC insulated cables for working voltages up to and including 1.1 kV.
- IS: 9537 Conduits for electrical installation.
- IS:3480 Flexible steel conduits for electrical wiring.



- IS:1239 Mild steel tubes, tubulars, and other wrought steel fittings. (For size above 63mm Dia of rigid conduits)
- IS:14768 Fittings for rigid steel conduits for electrical wiring.
- IS:3837 Accessories for rigid steel conduits for electrical wiring.
- IS:14772 Boxes for enclosures of electrical accessories.
- IEC 61000 Electromagnetic Compatibility
- BEE Code- Lighting- 2006 and subsequent updation IEC 62612.
- IS 16101 LED Lighting Fixtures
- SP 72 National Lighting Code

3.0 LIGHTING DESIGN

3.1. The plant lighting system shall comprise the following:

- Normal 230 V AC Lighting System

Normal AC lighting shall be provided by lighting distribution boards and lighting panel distributed throughout the plant. Supply to these lights shall be ON as long as the upstream AC supply is available. The 415/415 V Lighting Transformers shall be provided invariably between the I/C and MLDB. Any discrimination on account of fault level is not required. In case of failure of incoming supply to MLDB, internal batteries present inside the luminaires shall light up.

3.2. Lighting shall be provided in all the areas of the proposed plant. Lux level proposed are given below:

S.No.	Area	Lux level	Type of Fixture
1.	Switch gear /MCC rooms/panel rooms	200	LED industrial fixture
2.	Pump House, WTP area, Chlorination Building	100	LED industrial fixture
3.	Office area	300	LED industrial fixture
4.	Toilets, Staircases, Passages	100	LED industrial fixture
5.	Periphery, other area	50	LED industrial fixture

3.3. For indoor Areas, average lumen method shall be adopted to calculate luminance. Lighting level design shall include a Maintenance factor as follows to account for lamp lumen depreciation, luminaries' surface dirt and room surface dirt, etc.

- Air-conditioned clean interiors such as office rooms, : 0.8



- Control and Switchgear room :0.70
- Clean interiors such as office rooms, laboratories : 0.75
- Industrial areas with normal interiors such as workshops. : 0.7
- Industrial areas with dusty interiors : 0.6
- Industrial areas with very dusty interiors : 0.5

3.4. Lighting level design shall also include the coefficient of utilization factor as calculated from the table of reflectance provided by the manufacturer for the respective type of fixture.

3.5. All outdoor lighting DB, Power Panel, and Welding Receptacles suitable extended SS-304 grad rain hood / canopy shall be provided.

4.0 LIGHTING CONTROL

4.1 Switch control shall be provided for controlling lighting fixtures located indoors.

4.2 Timer shall be provided at the Incoming of LDB.

4.3 Load on each lighting circuit and single-phase receptacle circuit shall be limited to about 1500 W and the number of luminaries connected to the lighting circuit shall be limited to about fifteen (15).

4.4 At least two 6/16 ampere, 230-volt AC, 3-W universal socket outlet with DP MCB + ELCB and indicating LED lamp shall be provided in offices, cabins, each room, plant area etc. Receptacles with decorative cover plates shall be used in office / Control rooms.

4.5 Minimum three numbers 32A, 230 V AC, 3-W, Single phase convenience receptacle of industrial type with DP MCB + ELCB and indicating LED lamp shall be provided near motor locations covering all motor in the plant area. The convenience outlets shall be spaced to provide access to any point in the interior industrial areas with a 25-meter extension cord. The welding receptacle shall be spaced at 25mtr intervals.

4.6 63A, 415 V, 3 phase welding receptacle with FP MCB + ELCB and indicating LED lamp shall be provided in the plant area.

4.7 Each lighting panel shall be provided with one earth leakage circuit breaker rated 30mA.

4.8 Each receptacle panel shall be provided with one earth leakage circuit breaker rated 30mA.



- 4.9 The outdoor Receptacles shall have IP 55 (minimum) protection. Receptacles shall be housed in a box made out of 1.5 mm thick Stainless Steel of Grade 304 with SS hinged doors with suitable locking arrangements. Door shall be lined with good quality gasketing. Receptacles with decorative cover plates shall be used for all indoor area.
- 4.10 Conduit fill criteria shall not be more than 40%. Conduits should have the minimum number of bends in their run with pull boxes at suitable locations. Conduits shall be sloped to avoid water accumulation and draining into the equipment at its end.
- 4.11 Emergency lights shall be provided in each area. These lights shall operate on AC changeover supply from the UPS distribution Board. Emergency AC lighting system shall generally be fed from normal supply and from emergency supply from UPS only during normal supply failure. Automatic change over scheme with sensing devices, MCB plus Contactor, auto manual selection, required interlocks etc. shall be incorporated in each lighting distribution board. Manual change over with interlock shall also be provided. Separate wiring and distribution board shall be provided from these lights. Separate modular switchboards for Emergency lighting shall be provided. Colour of the switchboard shall be different from normal switchboards.
- 4.12 Quantity of Emergency lights shall be atleast 30% of normal lights in each area.

5.0 EQUIPMENT DESCRIPTION

5.1 LIGHTING FIXTURES

- 5.1.1 LED light fittings shall be of the following types for the installations having room height of up to 5 meter
- Industrial trough type/Industrial general-purpose Rail type for all industrial areas
 - Corrosion-proof type for battery room and chemical areas, etc.,
 - 2C group Lighting shall be provided in the battery room.
 - Anti-glare mirror optic type for Control rooms housing VDUs.
 - Recessed mounted type for Control rooms.
- 5.1.2 LED light fittings with IP65 degree of protection shall be provided for the installations having room height of above 5 meters
- 5.1.3 AC lighting fixtures and accessories shall be suitable for operation on 230 V, AC, 50 Hz supply



with a supply voltage variation of $\pm 10\%$, frequency variation of $\pm 5\%$ and combined voltage and frequency variation of absolute sum of 10%.

- 5.1.4 Luminaires shall meet at least Electrical Safety Class-I as per relevant IS/IEC.
- 5.1.5 The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The LED luminaire housing should be made of non-corrosive high pressure die cast aluminum and the housing should be power coated grey, so as to ensure good weatherability
- 5.1.6 Colour designation of LED shall be cool day light minimum (5700 K) type for indoor LED luminaires. further for outdoor type luminaires, the colour designation shall be 5000k . The LED luminaires shall have minimum life of 25000 burning hours with 80% of lumen at the end of life
- 5.1.7 Adjacent light fixtures in each area shall be provided with alternate phase supply.
- 5.1.8 Separate conduits shall be used for different phases. Neutral wire and Earth wire size shall be same as Phase wire. For easy identification of phases, neutral and earth wires, the following colour wires shall be used.
 - a) R – Phase - Red
 - b) Y – Phase - Yellow
 - c) B – Phase - Blue
 - d) Neutral - Black
 - e) Earth - Green

5.2 Lighting distribution board

Lighting distribution board shall comprise, TPN MCCB as incomer and required no. of TPN MCCB feeders as outgoing feeders to feed lighting panels & small power panels. Astronomical Timer shall be provided for all outdoor lights. LDBs shall be constructed from 2.0 mm thick Galvanized steel sheet.

5.3 Lighting Panels & Small Power Panel

- 5.3.1 The panels shall be rated for 415 V, 3 phase, 4 wire, AC with neutral bus and suitable for either wall/column mounting. Indoor panels shall have degree of protection of IP 54. Panels shall be constructed from GS sheet. Sheet thickness shall be 2.0 mm.
- 5.3.2 Miniature circuit breakers (MCB) shall have thermal elements for overload protection and an



instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 10 kA (minimum) at 230 V AC.

5.3.3 Contactors shall be of the air brake type fitted with arc shields.

5.3.4 Lighting panel & Small Power Panel shall be provided with 415 V AC, 63A, TPN MCB with ELCB as incomer, required nos. of 20 A, 230 V AC, single pole MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit.

5.3.5 LED indicating lamps shall be provided for each incoming and each outgoing circuits for indicating circuit is "ON".

5.3.6 LED indicating lamps shall be provided for Indicating "ON", "OFF" and "Trip" for each incoming circuits.

5.4 Three Phase Industrial Receptacles

The welding receptacle shall be of 63 A, industrial heavy duty insulated type with 5pin (with earth connection) suitable for 415 V, 3 phase, 50 Hz supply. The receptacle with FP MCB + ELCB shall be housed in a 1.5mm thick SS-304 grade enclosure. The enclosure shall conform to the degree of protection IP-55 class. Socket shall be provided with safety cover. Robust mechanical interlock shall be provided so that the switch can only be turned on when the plug is fully engaged, and the plug can only be withdrawn when the switch is off. Terminal blocks of adequate rating shall be provided for incoming/loop-in-loop out connection.

5.5 Single Phase Industrial Receptacles

The single phase industrial insulated receptacles shall be heavy duty type rated for 20A, 230 V AC complete with DP MCB + ELCB and indicating lamp housed in 1.5mm thick SS-304 grade enclosure having degree of protection of IP 55. These shall be of three pin type with the third terminal connected to earth. MCB shall be provided for control. Supply plug and Socket shall be insulated. Socket shall be provided with safety cover. Robust mechanical interlock shall be provided so that the switch can only be turned on when the plug is fully engaged, and the plug can only be withdrawn when the switch is off. Terminal blocks of adequate rating shall be provided for incoming/loop-in-loop out connection.

5.6 Flush type indoor receptacles

Flush type 3 pin, 6/16A, 230 V AC sockets shall be provided for office rooms and control rooms. The receptacle shall be complete with 16A Plate type switch & safety shutter. It shall be housed in suitable 1.5mm thick SS-304 grade enclosure. Inside the enclosure, terminals



shall be provided for loop-in-loop out of 4 sq.mm copper conductor. Plugs shall be 2-pole, 3 wire, with a rating of 6 /16 ampere, 230 V AC.

5.7 PVC Wires

PVC wires shall be suitable for continuous conductor temperature of 70° C and short circuit conductor temperature of 160° C. PVC Wires shall have multi stranded copper conductor. The voltage grade of PVC wire shall be 1100V.

PVC Wires shall be minimum of 2.5 sq.mm/4 sq.mm size. The insulation material shall be resistant to flame, oil, acid, and alkali, halogen free and shall be tough enough to withstand mechanical stresses during handling. PVC wires shall have following colors.

- Red for R phase
- Yellow for Y phase
- Blue for B phase
- Black for Neutral
- Green for Earth wire

All terminal shall be of Stud type (screw drive operated) and wiring shall be terminated with tinned copper ring type lugs with insulated sleeve. 20% spare terminal shall be provided of each type.

5.8 Flexible Metallic Conduits and Fittings

Flexible metallic conduits shall conform to the requirements of IS:3480. Flexible conduits shall be made of strip steel which shall be of galvanized iron. The strip shall be of uniform width and thickness throughout. The strip shall be electro galvanized to a minimum thickness of 50 microns. The surface of the strip shall be thoroughly cleaned before application of protective coating. Pretreatment, before galvanization, shall conform to IS:6005. Flexible conduits shall be supplied with suitable end coupler nipple and check nut.

GI pipes shall be of medium duty as per IS: 1239

Hume pipes shall be of reinforced concrete conforming to class NP3 for road crossings as per IS: 458.

5.9 Switch Boxes

The switch boxes shall be of surface/flush mounting type with steel construction. Switch boxes shall have conduit knock out on the sides. Modular type switchboards shall be



provided for all indoor area. The switches shall be of quick make and quick break type and shall be of plate type. Two numbers 6/16A, 3 pin 230 V AC type sockets shall be provided with safety shutter in each switchboard. The switch box shall be flush mounted in places such as control rooms and office rooms. Separate modular switchboards shall be provided for normal and emergency lighting and having different color for ease of identification. Switches furnished shall be 16 Amps, 230 Volt totally enclosed plate type with side connected screw type terminals, phenolic compound housing and operating levers, and single mounting yoke design.

5.10 Lighting Junction Box

The junction boxes shall be of 1.5mm thick SS-304 grade weatherproof type. 1100V grade multiday terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires in the junction boxes. The Junction box shall be suitable for mounting on wall/column/poles/masts.

5.11 Fans

Ceiling fans shall be of reputed make, BIS approved, 1400 mm sweep complete with copper wound, class E insulated motor, three nos. balanced blades, suspension rod, canopy and other accessories conforming to applicable IS. Ceiling fans shall be supplied with a wall mounted controller to turn the fan on and off and to vary the fan speed from 0 to 100%. Controller shall be electronic type free from humming noise. Ceiling fan shall be of BLDC technology with highest energy efficiency rating (Specifications similar to Atom Berg). The electronic regulator for Ceiling fans will be housed in common modular switchboard for lighting and shall be of similar make and model as that of modular switches. Ceiling fan shall be provided in each room, indoor area etc. even if ACs are provided for that room, area. Pedestal fans shall be of reputed make, BIS approved, 500mm sweep, complete with Aluminium blades, cast iron base, copper wound, class E insulated motor, support column, control switch and other accessories conforming to applicable IS.

6.0 INSTALLATION

- 6.1. The bottom of wiring devices shall be mounted the following distances above the finished floor.

Wiring Devices	Location	Distance above Floor (minimum)
Receptacles	Offices and finished areas	500 mm
Receptacles	All other locations	900 mm
Switches	All locations	1500 mm



Wiring Devices	Location	Distance above Floor (minimum)
Ceiling fan control	All locations	1500 mm
Ceiling fans	All locations	2500 to 3000 mm

- 6.2. The location of the light fittings, receptacles, switches, etc. shall be such as to avoid interference with piping/ventilation ducts or other equipment and to avoid objectionable shadows and glare, stroboscopic effect etc.
- 6.3. In indoor areas the switchboards and the conduits shall be recess mounted.
- 6.4. In industrial buildings, wiring installation shall be carried out on surface conduits. In office building and other non-industrial buildings, concealed conduit wiring shall be adopted.
- 6.5. In the rooms where false ceilings are provided, the lighting fixtures shall be supported separately by false ceiling grid over false ceiling if it is of steel structural or from ceiling or from cable trough / channel and not by the false ceiling board. The arrangement shall be to the approval of Owner.
- 6.6. A four (4) way terminal junction box shall be provided near each lighting fixture, for loop-in, loop-out and off connection of lighting wires or as required.
- 6.7. Conduit in finished areas, such as office and control areas, shall be concealed. Conduit shall be routed at least 150mm from the insulated surfaces of hot water, steam pipes and other hot surfaces. Where conduit must be routed parallel to hot surfaces, special high temperature cable shall be used.
- 6.8. Conduits supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm vertical runs.
- 6.9. Conduit shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs.
- 6.10. Wiring for indoor Lighting installation shall be carried with PVC insulated wire following minimum sizes laid in FRPVC heavy duty conduit of
- Lighting Panel to lighting Fixtures : 2.5 sq.mm copper.



- Lighting Panel to Switch box : 2.5 sq.mm copper.
 - Switch box to lighting Fixtures : 2.5 sq.mm copper.
 - Lighting Panel to Sockets / receptacles: 4 sq.mm copper.
- 6.11. Voltage drop in the cable shall be limited as follows,
- Lighting panel to lighting fixtures : 3 %
 - Switchbox to lighting fixtures : 1.5%
 - Lighting panel to socket : 3%
 - Lighting panel to switch box : 1.5%
- 6.12. Wiring for lighting fixtures and receptacle units shall be fed from different circuits and shall run in separate conduits. Two different phase circuits shall not be laid in the same conduit.
- 6.13. All conduits shall be surface mounted in plant area general except indoor area. In Office rooms & Control rooms conduit shall be concealed type. Minimum 3Cx2.5sqmm 1.1V grade XLPE/PVC insulated PVC inner sheath, GS armour overall PV insulated cable shall be used for outdoor area.
- 6.14. Ceiling fans with variable speed electronic regulators shall be installed in the non-air-conditioned areas as specified. Ceiling Fans & pedestal fans for of required size and quantity to be provided in individual rooms / areas like Workshop, Stores, Office building / areas, Service building, etc.
- 6.15. Receptacles and lighting circuits shall be fed from different circuits. The switch controlling these circuits shall be on the live side (phase wire) of the circuits.
- 6.16. Wiring shall be spliced only at junction boxes. only one wires shall be connected at each terminal.
- 6.17. Lighting branch circuits shall be routed in conduit. Lighting circuits shall be routed in electrical metallic tubing (EMT) for indoor areas.



7.0 TECHNICAL PARAMETERS

S.No	Item Description	Rating
1.	Illumination design categories	Normal lighting system
2.	Type of Luminaries	General purpose LED luminaries
3.	Lighting Distribution boards categories	25kA for 1Sec, lighting distribution panels
4.	Wiring	Halogen free Flame retardant cables for Normal lighting system
5.	Spare	10% or minimum 1 no of each Item of Illumination system
6.	Make of Lighting Fixtures & its accessories	1. Philips 2. CGL 3. Bajaj 4. Wipro 5. Havells

L. EQUIPMENT LIST

Sl.No	List of Equipment
1	UF feed Pumps
2	ASC Filter cleaning pumps
3	ASC Filter Backwash Pump
4	UF Backwash Pumps
5	UF CIP Pumps
6	UF Air Blower
7	RO Feed Pumps
8	RO High Pressure Pumps
9	RO Booster Pumps
10	RO CIP Pumps
11	RO Permeate Transfer Pump
12	RO reject Transfer Pump
13	UF Dosing pumps
14	RO dosing Pumps
15	Any other Pumps



MCC 1 (0.5 MLD Desalination Plant 1)

Sl. No	List of Equipment
1	UF feed Pumps
2	ASC Filter cleaning pumps
3	ASC Filter Backwash Pump
4	UF Backwash Pumps
5	UF CIP Pumps
6	UF Air Blower
7	RO Feed Pumps
8	RO High Pressure Pumps
9	RO Booster Pumps
10	RO CIP Pumps
11	RO Permeate Transfer Pump
12	RO reject Transfer Pump
13	UF Dosing pumps
14	RO dosing Pumps
15	Any other Pumps

MCC 2 (0.5 MLD Desalination Plant 2)

Sl.No	List of Equipment
1	Clarified Water Pumps
2	Chemical dosing skids

Pump House

- Following Feeders have been provided for 4 (three) nos Boreholes:

Sr. No.	Feeder Description	Rating (Amp)	Feeder NO.	Feeder Location	Distance (approx.)
1	BOREWELL-03	100	TBA	DESAL PLANT MCC	4.0Km
2	BOREWELL-02	100	TBA	DESAL PLANT MCC	2.0Km
3	BOREWELL-01	100	8F1	PIDB at PSS-2	3.7Km
4	BOREWELL-04	100	TBA	PIDB at PSS-2	350m

- The distance indicated in the above table is approximate, however bidder to measure actual length and to calculate the voltage drop and size of the cable accordingly. Cables routes in allocated cable corridor shall be finalized as per Owners requirement during detailed engineering. If required, Bidders may check the Cable routes during site visit.



- Bidder to design cables for Boreholes considering location of supply feeders (as mentioned above), cable Routes, Voltage Drop, starting voltage etc. Cable route shall be selected near road for proper laying and future replacement & O&M.

Sl. No.	Feeder Description	Rating in KW	Cable Size	
			From PIDB Feeder to DB	DB to Motor
1	BOREWELL-04	45	3C+E 95sqmm Cu	3C+E 35sqmm Cu
2	BOREWELL-03	45	3C+E 400sqmm Cu	3C+E 35sqmm Cu
3	BOREWELL-02	45	3C+E 400sqmm Cu	3C+E 35sqmm Cu
4	BOREWELL-01	45	3C+E 400sqmm Cu	3C+E 35sqmm Cu

Tentative Cable size

- Cable size indicated is tentative and Bidder to design cables for Boreholes considering location of supply feeders (as mentioned above), cable Routes, Voltage Drop, starting voltage etc.
- The incoming power supply to the MCC of the Desalination Plant will be taken from the PIDB of PSS-1 as one of the Incomer and another incomer from the LT panel located at the North Gate of PSS-1. All downstream distribution for motors and associated loads shall be fed through the MCC dedicated to the Desalination Plant. All other miscellaneous loads shall be equally distributed in each Bus. Sufficient sizes cables along with all required termination accessories, support arrangements, precast cable trench (identical to cable trench provided in GIPCL PSS-1), GS cable trays with covers, cable supports arrangements etc. from above feeders at PSS-1 to Desalination plant shall be in the scope of Bidder.

Borewell-2 and Borewell-3, Cables as per cable sizing calculation from feeders of Desal plant MCC shall be laid above ground (on RCC cable support blocks at minimum height of +500mm above NGL with distances between blocks not more than 2 mtrs) in allocated cable corridor only by bidder. Complete modules with all required protection & measurement, all Auto/Manual as well as Local and Remote control with required interlocks etc. complete in all respect shall be provided by bidder in local panel located in Desalination plant for Borewell-2 & Borewell-3. Horizontal drilling shall be done for Road crossings, drain crossing, cable crossing, other crossing etc. and dedicated DWC/HDPE pipe shall be provided for each cable at each location.

Borewell-1 & Borewell-4 Soft start feeders provided at PIDB located at GIPCL PSS-2. From this Modules further cables as per approved cable sizes shall be Laid above ground in



allocated cable corridor (on RCC cable support blocks at minimum height of +500mm above NGL with distances between blocks not more than 2 mtrs) for Borewell-1 & 4. All required protection & measurement, all Auto/Manual as well as Local & Remote control with required interlocks etc. complete in all respects shall be provided and done by bidder for Borewell-1 & 4. Detailed operating philosophy shall be submitted. Horizontal drilling shall be done for Road crossings, drain crossing, cable crossing, other crossing etc. and dedicated DWC/HDPE pipe shall be provided for each cable at each location.

Feeders for the Proposed Pump House Loads like Clarified water pump to tank and chemical dosing skids, etc. shall be provided at the Desal Plant MCC (As per tentative SLD). Feeders for the any other loads required for Desal plant like discharge pumps, supply pumps, any other pumps etc. shall be provided at the Desal Plant MCC. Further, Load shall be equally distributed on each Bus as well as design shall be such that fault in any bus will not affect the pump house operation.

One spare feeder shall also be provided for Permeate water (for Sterling Wilson).



ANNEXURE 1 - DATASHEET TO BE FILLED IN BY BIDDER

S. No.	Description	Units	Indicative Data	Data by Bidder
	Lighting System Design Data			
1.	Manufacturer and Country of Origin	-		
2.	Applied standards	-		
3.	Fixtures (Technical data sheet, COU table, Lumen output etc, for each type also to be furnished)	Nos.		
4.	Obstruction lighting (Technical data sheet, COU table, Lumen output etc, for each type also to be furnished)	Nos.		
5.	Socket outlets (Technical Data sheet also to be furnished)	Nos.		
6.	Power socket outlets (Technical Data sheet also to be furnished)	Nos.		
7.	Portable lamps (Technical Data sheet also to be furnished)	Nos.		
8.	Sub-distribution switchboards (Technical Data sheet also to be furnished)	Nos.		
	415 V / 230 V AC LIGHTING PANELS			
1.	Number of Panels	-	5	
2.	Manufacturer	-		
3.	Installation type of panel	-	Indoor / outdoor	
4.	Busbar material	-	Copper	
5.	Minimum clearance distance			
	live part to earth	mm		
	between phases	mm		
6.	Sectional area of busbars	mm ²		
7.	Plug-in units (yes/no)	Yes/No	Yes	
8.	Rated voltage	kV	0.415 / 0.230	
9.	Rated busbar current (Horizontal busbar)			



S. No.	Description	Units	Indicative Data	Data by Bidder
	To IEC	A/A		
	At 55°C	A/A		
10.	Rated busbar current (Vertical busbar)			
	To IEC	A/A		
	At 55°C	A/A		
11.	Rated frequency	Hz	50 Hz	
12.	Test voltage	V		
13.	Max. asymmetric 3-phase short-circuit withstand current	kA peak		
14.	Short time rated:			
15.	Current	kA	10	
16.	Time	s	1	
17.	temperature rise	Deg C		
18.	Degree of Protection	-		