ODISHA POWER TRANSMISSION CORPORATION

TECHNICAL SPECIFICATION

FOR

220 & 48 V VOLTS LEAD ACID PLANTE & 220 V VRLA TYPE STORAGE BATTERY ALONGWITH

BATTERY CHARGER

I- **a) 350AH/ 220V PLANTE BATTERY (FOR 132 and 220KV S/S)**
b) 645 AH for 220V BATTERY(FOR 400 KV S/S).
c) 220 V, 350 AH, Maintenance Free VRLA Type Battery.

II- **BATTERY CHARGER SUITABLE FOR 350 AH & 645 AH for 220V**

CONTENTS

Clause No. **Part A** **TITLE**
[Lead Acid Plante & VRLA (48 V) Storage Battery)

Part – B [CHARGER]

PART – A

TECHNICAL SPECIFICATION FOR 220 VOLTS LEAD ACID PLANTE STORAGE BATTERY

A.1. SCOPE :

A.1.1. These specifications cover the design, manufacturer, assembly, shop testing at manufacturer's works before despatch, supply and delivery at SITE and erection testing and commissioning of 220 volt lead Acid Plante Storage battery.

A.1.2. The scope of supply shall include all parts and accessories etc. which are usual and necessary for erection, operation and maintenance of the battery banks and the chargers, as specified, above though not individually and specifically stated or enumerated.

A.2.0. STANDARDS :

2.1. The equipments shall comply in all respects with the latest edition of relevant Indian Standard Specifications except for the modifications specified herein. The equipments manufactured according to any other authoritative national / international standard which ensure an equal or better quality than the provisions of these specifications shall also be acceptable. Where the equipment offered conform to any other standard, salient points of differences between the proposed standard and the provisions of these specifications shall be clearly brought out in the tender. A Xerox copy of such standards [in English shall be enclosed with the offer].

2.2. A LIST OF RELEVANT STANDARDS IS GIVEN BELOW :

[i]	IS-1652-1991	-	Specification for stationery cells and batteries, lead Acid type with Plante Positive Plates
[ii]	IS : 266-1993	-	Specification for Suphuric Acid.
[iii]	IS-6071-1986	-	Specification for synthetic separators for lead acid batteries.
[iv]	IS:1069-1993	-	Specification for quality tolerances water for storage batteries.
[v]	IS:1146-1981	-	Specification for rubber and plastic containers for lead acid storage batteries.
[vi]	IS:8320-2000	-	General requirements and methods of tests for lead-acid storage batteries.
[vii]	IS:1885-Part-8/1996		Electro technical vocabulary-stationary cells & batteries.
[viii]	IEEE-485/1983	-	IEEE recommended practice for sizing large lead storage batteries for generating stations and sub-stations.

A3.0 INSTALLATIONS :

A3.1. Equipments covered under these specifications shall be suitable for indoor installation.

A4.0 PARTICULARS OF THE SYSTEM:

A4.1. One set of 220 Volts, 350AH and 645 AH capacity battery alongwith equipments such as boost charger, trickle charger shall be sufficient to cater to the DC power requirements in the Sub-stations as proposed. The system offered should be suitable to OPTCL system.

A.5.0 GENERAL REQUIREMENTS OF THE EQUIPMENTS :

General requirement of the different components of the Battery system are given below.

A5.1 One set of 220V,350 & 645 AH lead acid type plante storage battery set is required for meeting the D.C. load requirements of indicating lamps, emergency lighting, relays, alarms, circuits breakers etc. The battery shall be kept in healthy conditions with the help of the existing float charging unit. The existing boost charger unit shall supply quick charging current to bring back the battery to fully charged conditions after it has discharged to a considerable extent while meeting the emergency load. The battery shall meet practically all the heavy current demands, as required for operation [closing and / or operating of circuit breakers, emergency lighting load and field flashing load etc). It should be noted that, the 220V batteries are to be accommodated in the Battery Room and should operate satisfactorily over the entire range of ambient temperature of 0^0 C to 50^0 C and relative humidity of 95%.

A.6.0. DETAILS OF SPECIFICATIONS OF PLANTE BATTERIES Type Battery:

6.1. The batteries shall be made of closed type lead acid cells with 'plante' type plates manufactured to conform to IS: 1652-1991.

6.2. CAPACITY :

6.3. The capacity of the batteries shall be as follows :

[i] Voltage. - 220V/48 V

[ii] Output at 27^0 C - 350AH/550AH at 10 hrs. discharge rate.

The batteries shall normally remain under 'floating' condition with the 'trickle' charger supplying the continuous load. However, the batteries shall be capable of supplying the following loads under emergency conditions without any assistance from the chargers and without their terminal voltage falling below 200 V [90% of rated voltage]

350AH/645AH

[I] I stage [continuous]- 35A for 10 hours. ,65 A for 10 hours

[ii] Stage emergency - 15A for 3 hours for lighting.

6.4. The number of cells for the 220 V/48V batteries shall be so chosen that for the nominal floating voltage of the cells, the battery voltage shall be 237.5V/51.85V and for the minimum [discharged condition] voltage of the cells, the voltage of the battery shall not be less than 198V/43.2V, while the assigned rating of the battery bank can not lowered below its rated voltage of 220/48V volts.

A7.0 DESIGN AND CONSTRUCTION DETAILS : (For Plante Type)

7.1 **Containers** : The containers for the cells shall be of impervious, moulded transparent, plastic/glass material having heat-resisting, high strength, non-reacting and low inflammable properties conforming to IS-1146-1981. The containers shall be mounted on insulators blocks. The containers shall be of robust construction and free from flaws, bubbles or foreign matter. The surface of the containers shall have a finish substantially free from blisters, rough spots, scales, blow holes and other imperfections or deformations. The handle bars, if provided, shall be of such that sufficient sediment space shall be available and the batteries will not have to be cleared out during their normal life. Battery containers shall be subjected to type, Routine and Acceptance Tests as per the requirements of IS-1146-1981. The containers of the label attached firmly to the containers shall be marked with the information as per requirements of cl No. 2.2 of the above standard. The supplier's manufacturer's test certificates shall be submitted by the tenderer for the scrutiny of the purchaser.

7.2 **Plates** : The positive plates shall be of pure lead lamelle type with plante formation. The negative plates shall be pasted antimonial-lead Grid type so designed as to hold the active material securely in place and in firm contact with the grid during service. The plates shall be designed for maximum durability and shall not buckle during all service conditions including high rate of discharge and the fluctuation of load.

7.3 **Separators** : The separators shall be of synthetic material conforming to the latest edition of IS-6071-1986. These shall permit free flow of electrolyte and would not be affected by the chemical reaction inside the cell and shall last for indefinite time. The internal resistance factor of the separators shall assure high discharge characteristics under all operating conditions. Proper arrangement to keep end plates in position shall be furnished by the bidder alongwith his offer.

7.4 **Electrolyte** : The electrolyte shall be prepared from the battery grade sulphuric acid conforming to IS-266-1993 and shall have a specific gravity of 1.2 at 27^0C. The sulphuric acid of battery grade shall be colourless liquid. The concentrated sulphuric acid on dilution with an equal volume of distilled water shall be free from suspended matter and other visible impurities. The sulphuric acid shall meet the requirements of columns – 4 and 5 Table –1 of IS-266-1993. The requisite quantity shall be despatched in non-returnable containers suitably packed and marked as per the requirements of the above Indian Standards. The container materials and packing shall be subject to approval of the purchaser.

Sufficient quantity of distilled water conforming to IS-1069-1993 shall be supplied in non-returnable containers to correct the level of electrolyte during initial testing and commissioning. The material of containers and packing shall be subject to the approval of the purchaser.

7.5. **Plate group bar with terminals** : The plate group bar with terminals shall conform to IS-1652-1991. The positive and negative terminals shall be clearly marked for easy identification. The legs of the plates of like polarity shall be connected to the load, turned to a horizontal group

bar having an upstanding terminal post adopted for connection to the external circuit. The group bars shall be sufficiently strong to hold the plates in position.

7.6. **Buffers/spring**: Suitable buffers / springs shall be provided in the cells to keep the end plates in position. These shall have adequate length and strength.

7.7. **Cell lids** : Lids used with sealed or closed type cells shall be of glass, plastic or ebonite and shall be provided with vent plugs. Terminal post shall be suitably sealed at the lid to prevent escape of acid spray, by means of rubber grommets, sealing compound or other suitable device. The positive and negative terminal posts shall be clearly and indelibly marked for easy identification.

7.8. **Water** :- Water used for preparation of electrolyte and also to bring the level of electrolyte to approximately correct height during operation / testing shall conform to relevant standards.

7.9. **Venting device** : The venting device shall be anti splash type and shall allow gases to escape freely but shall effectively prevent acid particles or spray from coming out. There shall be two vent holes, one serving as a guide for acid level indicator for checking the electrolyte level and other to permit drawing of electrolyte samples, servicing, checking of specific gravity etc.

7.10. **Marking** : Acid level line shall be permanently and indelibly marked around on all the containers.

The following information shall be indelibly marked on the outside surface of each cell :

[i] Manufacturer's name, type and trade mark.

[ii] Nominal voltage.

[iii] AH capacity at 10 hours rate with specified end cell voltage.

[iv] Cell number.

[v] Upper and lower electrolyte level in case of transparent containers.

[vi] Type of positive plate.

[vii] Type of container.

[viii] Date of manufacture [month and year] or [week and year].

A8.0. INSTALLATION OF BATTERY :

8.1. The battery set shall be installed on wooden racks in a separate battery room non air – conditioned but ventilated. The tenderer shall offer racks and mounting insulators etc.

8.2. The cell shall be arranged on the racks in a two-tier arrangement with two rows of cells on each tier or with some other suitable arrangement depending upon the availability of space inside the battery room. The lay out shall be subject to the approval of the purchaser. The racks shall be constructed of best quality seasoned **teak wood** / with metallic stand with at least three [3] coats of anti-acid paint of approved shade and also flame proof coating. These racks shall be such that cells are located at convenient height to facilitate maintenance and they may be so constructed so as to promote free access to the floor directly beneath the rack to facilitate easy cleaning of the floor. These shall be designed and arranged in such a way that easy handling of the cells is possible while in operation. Numbering tags for each cell shall be attached on to the racks.

8.3. The tenderer shall indicate and include the proposed arrangement of the batteries and include arrangement for fixing and mounting of inter-bank, inter-row, inter-cell and tap-off connectors etc.

A9.0. CONNECTORS:

Bars tinned copper lead connectors shall be employed for Inter-cell and inter-row, inter-tier connections. However, the tee-off connection from the battery unit shall be made with acid resisting cables of suitable size. A suitable terminal box alongwith acid-resisting cable shall be provided by the tenderer for this purpose. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and shall be provided with corrosion resisting lead coating.

The connectors shall be of sufficient cross-section to withstand all the working conditions including one minute discharge rate as well as short circuit conditions.

A.10. ACCESSORIES :-

The equipments and accessories, listed below shall be furnished as part of each battery set and the price of the battery quoted shall be inclusive of these items.

[a] Teak wood racks with three coats of anti-acid paint and flame-proof coating.

[b] Stand insulators +5% extra.

[c] Cell insulators +5% extra.

[d] All Cell interconnectors and end take-offs.

[e] Lead coated connection hardware such as bolts, nuts etc.5% extra. Or any other connector suitable for VRLA type Battery.

[f] Cell numbering tags with fixing arrangement.

[g] Teakwood, cable clamps with hardware.

[h] Diluted sulphuric acid of sufficient quantity and of specific gravity according to the relevant ISS and 10% extra shall be supplied in non-returnable acid proof containers, suitable packed.

[I] Two numbers cell testing centre-zero voltmeters 3-0-3 volts range, Accuracy class shall be 0.5 or better and resistance not less than 1000 ohms.

[j] One number syringe type hydrometer complete with accessories and suitable for measuring SP gravity between 1.1 to 1.320 with graduation of 0.005 Sp. Gravity together with temperature correction charts.

[k] One number floating hydrometer.

[l] Two numbers thermo-meters having range 0-100 deg. C whose one division of the graduated scale shall represent at the most 1 degree centigrade with separate gravity correction chart.

[Accuracy of calibration shall not be less than 0.5^0C]

[m] One number wall mounting teak-wood for hydrometers and thermo-meters.

[n] Two numbers acid-resisting plastic jugs [2 litre capacity]

[o] Two numbers plastic funnels.

[p] Two numbers rubber syphone.

[q] Two numbers rubber aprons.

[r] Two pairs of rubber gloves.

[s] Two pairs of rubber boots-knee height.

[t] Two sets special tools or tools required for connecting the terminals of the batteries.

[u] The battery terminals shall be brought out in a junction box to be mounted on the battery stands.

[v] Ampere-hour meter[10 hour discharge rate] of 600 –1250 AH range-1 no.

[w] Any other accessories, not specified but required for installation, satisfactory operation and maintenance of batteries for a period of 5 [five] years.

A.11.0 MAXIMUM SHORT CIRCUIT CURRENT :

The Bidder shall state the maximum short circuit current of each battery alongwith the safe duration in seconds which it can withstand. Methods, proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

A.12. **VENTILATION :**

The bidder shall indicate in his bid the requirements of ventilation in the battery room. The battery shall operate satisfactorily over the entire range of the temperature and humidity indicted in this specification without affecting its normal life. Bidder shall indicate the percentage reduction in battery capacity at the lowest temperature of 27 deg C. If any special ventilation requirements are necessary, the same shall be indicated.

A.13. CAPACITY :

The standard Ampere-hour capacity at ten hour rate shall be 350/550 AH with an end cell voltage of 1.85 volts/cell.

A.14. CHARGING :

The bidders shall state whether an equalising charge is recommended for the battery. If so, the equalising charge voltage, current, duration and the interval between the equalising charging shall be specified in the Data sheet. Bidder shall also indicate the requirements for boost charging.

A.15. LIFE :

The bidder shall quote in his offer the Guaranteed life of the battery when operating under the conditions specified.

A.16. INSTRUCTION MANUALS :

Eight sets of instruction manuals for installation, commissioning, charging and maintenance instruction shall have to be furnished.

A.17. TRANSPORT :

The batteries, accessories and racks etc. shall be suitably packed and transported to site.

A.18. TESTS:

A.18.1 TYPE TESTS : The bidder shall submit the test reports alongwith his offer for the following type tests, conducted on the offered samples as per relevant National Standard[s] within five years from the date of opening of the bid and test witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

[a] Verification of constructional requirements.

[b] Verification of dimensions.

[c] Test for capacity.

[d] Test for retention of charge.

[e] Endurance Test.

[f] Ampere-hour and watt-hour efficiency test.

[g] Test for voltage during discharge.

If the type test report [s] does/do not meet the requirements as per this specification, OPTCL at its discretion may ask the supplier to conduct the above type tests [s] at the supplier's cost in the presence of OPTCL's representative without any financial liability to OPTCL

A.18.2 ACCEPTANCE TESTS : Following shall constitute the acceptance tests which shall be test witnessed by the purchaser's representative at the works of the manufacturer at the cost of supplier.

[i] Verification of marking.

[ii] Verification of dimensions.

[iii] Test for capacity for 10 hours discharge rate along with the Test for voltage during discharge.

[iv] Ampere-hour and watt-hour efficiency test.

A18.3.1 The Purchaser may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.

A.18.3.2. The supplier shall arrange for all necessary equipments including the variable resistor, tools, tackles and instruments. If a battery fails to meet the guaranteed requirement, OPTCL shall have the option of asking the supplier to replace the same within 15 [fifteen] days from the date of declaring the same to be insufficient/failed / not as per the specification [s].

A.19. DRAWINGS / DOCUMENTS :

The tenderer shall submit the following drawings / documents along with his offer failing which the offer is liable for rejection.

[a] General battery arrangement, proposed size of individual and over all dimensions along with sectional views showing all connections etc.

[b] Pamphlets and technical literature giving detailed information of

the batteries offered.

The manufacturer shall submit the following drawings / documents in 7 [seven] copies within 15[fifteen] days from the date of issue of the purchase order for purchaser's approval. :-

[a] Lay out details of the batteries.

[b] OGA and cross-sectional details for battery cells.

[c] Instruction manuals for initial charging and subsequent charging.

[d] Technical data, curves etc.

A.20. GUARANTEED TECHNICAL PARTICULARS :

The Guaranteed technical particulars, as called for in the 'Annexure – I & II shall be furnished alongwith the tender. Any tender lacking complete information in this respect is likely to be rejected.

A.21. All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer

TECHNICAL SPECIFICATION
FOR
220VOLT, 350Ah MF-VRLA STORAGE BATTERY

A.1.0. **SCOPE:-**

A.1.1. This specification covers the design, manufacture, assembly, shop testing at manufacturer's works before despatch, supply and delivery at site and erection, testing and commissioning of 220 volt 350Ah MF- VRLA storage batteries.

A.1.2. It is the intention of the purchaser to install the most up to date type of equipment conforming to modern practices.

A.1.3. The scope of supply shall include all parts and accessories etc, which are usual and necessary for erection, operation and maintenance of VRLA batteries as specified above, though not individually and specifically stated or enumerated.

A.2.0. **STANDARDS:-**

A.2.1. All equipment and their accessories, covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards, published by the Bureau of Indian Standards including those, listed at Clause 2.6 in order that specific aspects under Indian climatic conditions are taken care of .

A.2.2. The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards, published by any other recognized National Standards Institution and latest publication of International Electro Technical commission [IEC].

A2.3. The equipment manufactured according to any other authoritative national / international standard, which ensures an equal or better quality than the provisions of these specifications shall also be acceptable. Where the equipment, offered conform to any other standard, salient points of differences between the proposed standard and the provisions of these specification shall be clearly brought out in the tender. A copy of such standards [in English] shall be enclosed with the offer.

A.2.4. The equipment shall conform to the Indian Electricity Rules, 1956 with latest amendments as regards safety earthling and other essential provisions specified therein for installation and operation of electrical plants.

A.2.5. All equipment shall also comply with the statutory requirements of the Government of Odisha where the equipment will be installed. Nothing shall be construed to relieve the supplier of his responsibility.

A.2.6. **GOVERNING SPECIFICATION:-**

The VRLA batteries and the associated chargers shall unless otherwise specified, conform to the following standards. The firms are requested to furnish the following specifications for our further reference.

i	IS-1651/1991	Specification for stationary cells batteries, leads acid type.
ii	IS-1885 [Part-8] / 1986	Electro technical vocabulary: Part- 8-Secondary cells & batteries.
iii	IS-266/1977	Sulphuric acid
Iv	BS-46290 (Part-4) / 1997	British standard specification for lead acid type valve regulated sealed type batteries.
v	ANSI, IEEE STD 450/1987	IEEE recommended practice for maintenance, testing and replacement of large lead storage batteries for generating stations and sub-stations.
vi	IEC 896-2/1995	Stationary lead-acid batteries, general requirements and methods of test (part-2, valve regulated types)
vii	IS-(1146 / UI-94) / ASTM - d -29863	Plastic container for lead acid storage batteries.

viii	IS-3136-1965	Specification for polycrystalline semiconductor rectifier equipment
ix	IS-1248-1968	Specification for direct acting indicating analogue electrical measuring instruments and tier accessories. (Part - I)-1983-General Requirements. (Part - II)- 1983 - Ammeters & voltmeters. (Part-III)-1984-Accessories.
x	IS-2208-1962	Specification of HRC Cartridge fuse link up to 650V
xi	IS-2959-1966	Specification of contractors for voltages not exceeding 1000V AC or 1200V DC
xii	IS-3395-1966	Specification for monocrystalline semiconductor rectified cells and stacks.
xiii	IS-4540-1968	Monocrystalline semiconductor rectifier assemblies & equipment
xiv	IS-2147/1962	Degree of protection provided by enclosure for low voltage switchgear and control gear
xv	IS-5578/1984	Guide for marking of insulated conductors.
xvi	IS-8623/1993 [Part 1 to 3]	Low voltage switchgear and control gear assemblies.
xvii	IS-11171/1985	Dry type power transformers.
xviii	IS-11353-1985	Guide for uniform system of marking and identification of conductors and apparatus
xix	IS-13947-1993 (Part 1 to 5)	Low voltage switchgear and control gear

A.3.0. **OTHER REQUIREMENTS:-**

A.3.1 **ACCESSIBILITY AND INTER CHANGEABILITY:-**

All working parts, in so far as possible, shall be arranged for convenience of operation, inspection, lubrication and case of replacement with minimum down time. All like parts of the equipment, furnished shall be inter changeable.

A.3.2. **QUALITY AND WORKMANSHIP:-**

Workmanship and materials shall be of good commercial quality, suitable for the purpose, intended and in accordance with the highest standards and practices for equipment of the class, covered by this specification.

A.3.3. **SAFETY**

A3.3.1.All equipment shall be complete with approved safety devices wherever a potential hazard to personnel exists and with provision for safe access of personnel to and around the equipment for operational and maintenance functions. The design shall include all necessary precautions and provisions for the safety of operating and maintenance personnel.

A3.3.2.Special care shall be taken to make enclosed equipment proof against entry of rat, lizards and other creeping reptiles, which may create electrical short circuits inside, live equipment.

A.3.3.3.Continuity of power supply is the first consideration and the design shall be such as to provide facilities to simplify inspection, testing maintenance, clearing and repair at site.

A.3.4. **SPECIAL SITE CONDITIONS:-**

A.3.4.4.The equipment with their accessories shall be designed for smooth, efficient and trouble free operation tropical humid climate for maximum temperature of 50 degree C and maximum humidity of 98 percent. Maximum temperature and maximum humidity are

however not likely to occur simultaneously. De-rating of equipment shall be done for an ambient temperature of 50 degree C.

A.3.5. **PAINTING:-**

All items of equipment and materials shall be thoroughly cleaned and painted in accordance with IS Specification. The clean surface shall be given two coats of epoxy polyamide resin based red-oxide zinc-phosphate primer, deposited either by immersion or powder spray. They phosphate coated surface shall have one coat of high build epoxy resin based intermediate paint coating and two coats of air drying epoxy polyamide enamel suitably pigmented finish paint. The colour shade for exterior parts of equipment located inside the sub-station control room building shall be as per shade No. 631. Clean and touch-up paint shall be applied at site as required.

A.4.0. **CONSTRUCTIONAL DETAILS OF VRLA BATTERY.**

A.4.1. **PLATES:**

Positive plates shall be made of flat pasted type using lead-Cadmium-antimony alloys for durability, high corrosion resistant, maintenance free, low discharge rates and long life both in cyclic as well as in the float applications.

Negative plates shall be heavy duty, durable flat plate using lead calcium ally pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of positive and negative plates shall ensure long life, durability and trouble free operation of the battery. PLC Operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of plate preparation is not allowed.

A.4.2. **SEPARATORS:-**

The separator shall be absorptive glass mat type or spun glass micro porous matrix type and shall be resistant to sulphuric acid. It shall be capable of keeping all the electrolyte and shall be electrically insulated. Sufficient separator overlap and PVC shield protection to top and bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates. The uncompressed water absorption of the separator shall be at least 5 gm. of water / gm of separator material.

A.4.2.1. **REQUIREMENT OF WICKING TEST ON SEPARATORS:-**

The total wicking height shall not be less than635 mm in 24 hours. The minimum water content at 125 mm. Height shall be at least 5 gm. of water per gm. of separator. The weight of water per gm. shall be at least 90% of the value at 125 mm when checked at a height of 450 mm.

A.4.3. **VALVE:-**

Safety valve vent plugs shall be provided in each cell. They shall be explosion resistant, self-resealing and pressure regulating type. They shall not allow gas (air) to enter into the cell but shall allow gas to escape from the cell above a certain internal pressure, which does not lead to deformation or other damage to the cell.

A.4.3.1. The vent plug used shall be explosion resistant and self re-sealing pressure regulating type. Vent plug shall be such tat it cannot be opened without proper tool.

A.4.3.2. The valve shall be so designed that it operates at a pressure between 0.14 Kg / Sq. mm to 0.63 Kg / Sq. mm to release the excess gas and reseal automatically as soon as the gas pressure within the cell drops to atmospheric value.

A.4.3.3. All the cells shall be subjected to pressure test upto 0.7 Kg / Sq. mm.

A.4.3.4. The self-discharge rate at room temperature shall not be more than 5 % of the capacity of each battery per month.

A.4.3.5. Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

A.4.4. **CONTAINERS AND LID:-**

A.4.4.1. The container shall be made up of a special grade polypropylene copolymer plastic material, which should be of flame-retardant.

A.4.4.2.The container shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range, naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapor permeability.

A.4.4.3.The container shall be enclosed in epoxy coated steel trays. The steel trays shall be so designed as to make both vertical and horizontal stacking of cells / batteries possible.

A.4.5. **LIDS / COVERS:-**

Sealed maintenance free batteries shall have polypropylene copolymer covers. The complete container along-with lid / cover shall be able to withstand without fracture for 5 hours at 25 degree Celsius at an internal pressure of 5 times the normal operating pressure as declared by the manufacturer. The complete design includes the pillar to lid seal, which shall be designed to remain gas-tight and electrolyte-tight during the designated life of the battery.

A.4.6. **PILLAR SEAL ASSEMBLY:-**

A.4.6.1.The pillar to lid seal shall be designed to remain gas-tight and electrolyte-tight during the designated life of the unit. The terminal shall conform to Class 3.2 of BS: 6290, Part - 4 - 1987.

A.4.7. **ELECTROLYTE:-**

The electrolyte shall be prepared form the battery grade H2 SO4 conforming to ISS:266. The batteries shall be supplied in factory filled charged condition. All the acid will be in immobilized condition the AGM separator.

A.4.8. **WATER:-**

Water required for preparation of electrolyte shall conform to IS:1069.

A.4.9. **CONNECTORS AND FASTENERS:-**

Lead or lead coated copper connectors shall be used for connecting up adjacent cells and rows. The thickness of lead coating of connectors should be not less than 0.025 mm. The lead coating thickness shall be measured in accordance with APPENDIX-F of IS : 6848 : 1979. All the terminals and cells inter connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cable having stranded aluminum / copper conductors and PVC / XPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the supplier. All connectors and lugs shall be capable of continuously carrying the 30 minute discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Bidder shall furnish necessary sizing calculations to prove compliance to the same.

A.4.10.**PLATE CONNECTIONS:-**

Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be casted with lead alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

A.4.11.**NUT & BOLTS:-**

Nuts and bolts for connecting the cells shall be made of copper, brass or superior grade passivated stainless steel which should be resistant to sulphuric acid. Copper & brass shall be coated / plated with suitable materials such as Nickel / Chrominium to prevent sulphation or corrosion.

A.4.12.**TERMINALS:-**

Terminals shall be of integral lead terminal with solid copper core with M6 threading for fastening. The junction between terminals posts and cover and between the cover and container shall be hermetically sealed.

A.4.13.**SEAL:-**

(i) TIG welding shall be dove for post sealing.

(ii) Additional Epoxy resin sealing shall be provided for double assurance against leakage.

A.4.14.**SUPPORTING RACKS:-**

Batteries shall be installed on MS racks to be supplied by the supplier to fit in the battery /battery charger room. Racks / trays shall be powder coated with anticorrosive paint and supplied in unassembled state. Rack / tray shall be subjected to 7 tank process before

painting for protection against fungus growth and other harmful effect due to tropical environment.

The steel trays / containers shall be stackable one over the other horizontally in multi-tier arrangement. The bottom most tray shall be mounted on I-channels with 150 mm height. The positive and negative terminals shall be terminated onto the terminal plate assembly, which is fitted to one of the steel tray depending on the convenience at site.

A.4.15. **MARKING:-**

The following informations shall be legibly laid durably marked on each cell battery:-

6. Nominal Voltage.
7. Name of the manufacturer and type reference.
8. Rated or nominal capacity expressed in ampere hour (AH) with an indication of the rating expressed either as a current or as time together with the relevant final voltage of each cell.
9. Voltage for float operation 27^0 C with tolerance of 1%.
10. Cell number.
11. Type of positive plate.
12. Type of container.
13. Date of manufacture (month and year) or (week and year).

A.5.0. **MAXIMUM SHORT CIRCUIT CURRENT:-**

The bidder shall state the maximum short circuit current of each battery along-with the safe duration in seconds, which it can withstand. Complying with clause 5.5 of IEC – 896 – 2/1995. Method proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

A.6.0. **VENTILATION:-**

The Bidder shall indicate in his bid the requirements of ventilation in the battery room. The battery shall operate satisfactory over the entire range of temperature indicated in this specification without affecting its normal life. Bidder shall indicate the percentage reduction in battery capacity at the lowest temperature of 27 Degree C. If any special ventilation requirements are necessary, the same shall be indicated.

A.7.0. **CAPACITY:-**

The standard Ampere-hour capacity at ten hour rate shall be 200, 300 and 500 AH and end cell voltage of 1.80 volts /cells.

A.7.1. **SELF DISCHARGE RATE OF BATTERY:-**

Self discharge rate shall be less than 0.5% of C 10 Capacity per week at 27degree C.

A.8.0. **CHARGING:-**

The bidder shall state whether an equalizing charge is recommended for the battery. If so, the equalizing charge voltage, current, duration and the interval between the equalizing charging shall be specified in the Data Sheet. Bidder shall also indicate the requirements for boost charging.

A.9.0. **LIFE:-**

The bidder shall quote in his offer the guaranteed life of the battery, when operating under the conditions, specified. The bidder shall also quote the change in life of the battery due to change in temperature form 27 degree centigrade in the event the batteries are required to be operated under higher temperature environment.

A.10.0. **DESIGN VALIDATION:-**

Over the range of manufacturer's capacity, at least one capacity should have been tested and should meet the requirement of Service Life as per ANSI TI : 330 Specification. Necessary evidences maybe enclosed along-with the offer.

A.11.0. **MAINTENANCE TOOLS & INSTRUCTION:-**

A.11.1. One cell – testing –center-zero volt meter 3-0-3 volt range of accuracy class not less than 0.5 shall have to be supplied alongwith each of the battery sets. The resistance of the voltmeter shall not less than be 100 ohms.

A.11.2. Eight sets of instruction manuals for installation, commissioning and initial charging, the calculations of charging / discharge under float and boost charging and maintenance instructions shall have to be furnished.

A.11.3.It is mandatory for the bidder to provide with the spare relating to the batteries including cells for replacement for a minimum period of 8 years and above.

A.12.0.**ELECTRICAL CHARACTERISTICS:-**

DESIGN SHOULD ENSURE THAT:-

(a)Battery shall be suitable for constant current constant voltage charging.

(b)Nominal float voltage shall not exceed 2.25 V per cell @ 27 degree C.

(c)Recharging shall be done at normal float voltage.

(d)Charging current shall not exceed 0.15 C. Where C is the capacity in AH @ 10 hours of discharge to end cell voltage 1.80 V @ 27 deg C.

(e)Except during commissioning. Battery shall not demand boost charging at any point of time during its operation.

(f)Battery shall not demand equalizing charge at any point of time during its operation.

A.13.0.**PROCESS REQUIREMENT:-**

(a) 100% cells shall be tested by Helium. I on leak tester for leak free performance. Vendor shall attach a copy of the Helium. I on tester report along with the dispatch documents.

(b) Vendor is expected to monitor the voltage and current data of the cells during initial charge and test discharge by means of automatic data logging for treceability. Vendor shall maintain the database of the same and provide the document to the company as and when called for.

A.14.0.TESTS

A.14.1.TYPE TESTS:-

The bidder shall submit the test reports along with his offer for the following type tests, conducted on the offered samples as per relevant National Standard (s) within five yeas from the date of opening of the bid and test witnessed by any Government Department / Government undertaking failing which the offer is liable for rejection.

(a) Verification of constructional requirements.
(b) Verification of dimensions /weight.
(c) Test for capacity.
(d) Test for charge retention.
(e) Endurance test.
(f) Ampere-hour and watt-hour efficiency test.
(g) Test for voltage during discharge.
(h) Test for endurance under short circuit conditions.
(i) Test for gas recombination efficiency.
(j) Wicking test Separators.
(k) Service Life test as per ANSITI : 330 Specification.

If the type test report (s) does / do not meet the requirements as per this specification. GRIDCO at its discretion may ask the supplier to conduct the above type test (s) at the supplier's cost in the presence of GRIDCO's representative without any financial liability to GRIDCO.

A.14.2.**ROUTINE TESTS:-**

All the routine tests, listed below shall be carried out on all the cells, containers. Hardware being supplied as per latest issue of BS : 6290, Part – 4. IE C89-I or IEEE – 1188 (whichever is applicable) at the cost of the supplier.

(a) Container

(i) Verification of constructional requirements.
(ii) Verification of marking and packing.
(iii) High voltage tests (Cl : 7.6 of IS : 1146).

(b) Cells and batteries:-

(i) Verification of constructional requirements.
(ii) Verification of markings.
(iii) Verification of dimensions.

A.14.3.0.**ACCEPTANCE TESTS:-**

Followings shall constitute the acceptance tests which shall be test-witnessed by Purchaser's representative at the works of the manufacturer at the cost of the supplier.

1. Verification of dimensions.
Verification of marking.
3. Tests for capacities for 10 hours discharge rate alongwitht the test for voltage during discharge.
Ampere-hour and watt-hour efficiency test.
5. Short circuit current test of batteries (arrangement for this shall be provided
6. during testing).
Resistance of cell / batteries.
8. Pressure of vent plug connected with battery (measuring shall be provided during testing).
9. Measurement of weight / material type and dimension of cell / racks / batteries and all other accessories as per approval of drawings / technical data submitted during tender process. All these shall be submitted in detail with the submission of tender paper.

A.14.3.1. The purchaser may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.

A.14.3.2. The supplier shall arrange for all necessary equipments, including the variable resistor, tools, tackles and instruments. If a battery / battery charger fails to meet the guaranteed requirements, GRIDCO shall have the option of asking the supplier to replace the same.

A.15.0. **DRAWINGS / DOCUMENTS:-**

The tenderer shall submit the following drawings documents along with his offer failing which the offer is liable for rejection.

(a) General battery arrangement including proposed size of individual and over all dimensions along with sectional views showing all connections etc.

(b) Pamphlets and technical literature giving detailed information of the batteries offered.

The manufacturer shall submit the following drawings / documents in7 (seven) copies within (fifteen) days from the date of issue of the purchase order for purchaser's approval.

(a) Layout details of the batteries with all accessories.
(b) OGA Cross-sectional details for battery cells.
(c) Instruction manuals for initial charging and subsequent charging.
(d) Technical data, curves etc.

A.17.0. **TRAINING:-**

The bidder shall arrange for training of at least five Telecom. engineering personnel of OPTCL on operation and maintenance of the VRLA type of batteries at free of cost. Every detail regarding the intricacies of these special type batteries need be imparted to the trainee engineers at works of the manufacturer. The bidder in their offer need intimate the duration of training. However the training must be imparted prior to the delivery of the battery sets.

A.18.0. **TRANSPORT:-**

The charged batteries, accessories and racks shall be suitably packed and transported to site in ready to use condition.

ANNEXURE -1A

SPECIFICATION FOR 350AH 220 VOLT MF-VRLA BATTERY SYSTEM

[To be filled in by the bidder]

SL. NO.	SPECIFICATION	CONFIRM / NOT CONFIRM
1	Maintenance free valve regulated sealed type acid battery 200,300 and 500 AH. 2V per cell [Total 24 Nos. battery cells]	
2	The cells should be assembled in stack over insulated steel rack to make 48 Volt / 200,300,400, 510 & 800AH battery system for Power Line Carrier Communication application.	
3	The steel rack will be placed over porcelain. Hard rubber insulator of 100 mm Height [approx.] to minimize leakage current to ground	
4	All the battery cells are to be assigned with number	
5	The final positive and negative terminals are to be brought to the terminal plate assembly (TPA). Suitable arrangement should be made for terminating the cables at the TPA	
6	Test for capacity of batteries should conform to IS: 1652 (Clause 11.6)	
7	The battery should be supplied with all accessories like connectors, links, S.S. nuts. Bolts and insulator etc.	
8	All the portion of connectors and adjacent steel plates are to be sleeved and insulated.	
9	Discharge test of batteries at 10 hr. rate of discharge to end cell voltage of 1.85 volt per cell to conform to the requirement of IS : 1652. Clause - 11.7 (Test for capacity) should be carried out by the supplier at the works of manufacturer and at the site. The ambient temperature at the place of installations will be considered for the calculation period of discharge.	
10	The battery should have a life expectancy of minimum 8 years at battery room ambient temperature that varies from a minimum of 20 degree centigrade during winter season and a maximum of 50 degree centigrade during peak summer. The tenderer should submit the relevant technical literature preferably in p from with details design calculation graph documents etc. in support of indicated life of the battery taking care of the above seasonal ambient temperature variation.	
11	The supplier should submit the documentary evidence) P.O. copy) for supply, installation land commissioning of battery capacity of 200,300,400,510 & 800 AH or higher capacity to the PLCC. Systems under any GRID Sub-stations and the same is in successful operation for a minimum period of 5.	
12	The watt-hour and ampere-hour efficiency and internal resistance value of the battery should be furnished.	
13	The supplier should show the values of internal resistance of all the cells at the time of commissioning at site and the same should confirm to the value indicated by them in their technical bid.	
14	The procedure of charging the battery before the capacity test should be furnished. The battery et will be inspected tested at works before despatch to store site.	

ANNEXURE IIA

SCHEDULE OF GUARANTEED TECHNCAL PARTICULARS FOR 220 VOLT 350 AH MF-VRLA LEAD ACID STORAGE BATTERY

(TO BE FILLED IN BY THE BIDDER)

1	Manufacturer's name and address :			
2	Conforming to standards.			
3	Type and designation as per IS.			
4	Manufacturer's type and designation			
5	Capacity of battery bank at the following discharge rates at 27^{0}C	Cap. AH	Rate of Disch. Current	End Cell voltage
	a. 15 minutes. b. 30 minutes. c. 45 minutes. d. 1 hour e. 2 hours f. 3 hours. g. 4 hours. h. 5 hours. i. 6 hours. j. 7 hours. k. 8 hours. l. 9 hours. m. 10 hours.			
6	Number of cells in the battery.			
7	Method of interconnection between cells.			
8	Maximum short circuit current of battery when short circuit is at the end of terminals			
9.	Recommended float-charging voltage across the battery terminals (volts).			
10	Recommended boost charging voltage across battery terminals (volts).			
11	Time required for boost charging from discharged conditions (in hours).			
12	Recommended trickle / float charging rate			
13	Recommended boost charging rate.			
14	Trickle charging current range / cell.			
15	Shelf life of charged battery bank.			
16	Open circuit voltage of battery bank when fully charged.			
17	AH capacity at 10 hours rate at room temperatures of:-			
	a. 15^{0}C. b. 27^{0}C c. 50^{0}C			
18	Cell Particulars:-			
	Material of container. Overall dimensions of each cell. Weight of cell complete with acid.			
19	**Voltage:-**			
	a. Open circuit voltage of cells. b. Float charging voltage. c. Boost charging voltage.			
20	Type of material / thickness / dimension of positive plates.			
21	Type of material / thickness / dimension of negative plates.			

22	Separators:-
	a. Type. b. Materials. c. Thickness of separator.
23	Type of valve provided.
24	Internal resistance of each cell at
25.	**Clearance in mm between.**
	a. Top of plates and top of container. b. Bottom of plates and bottom of container. c. Edges of plates and inner surface of container.
26	**Maximum ambient temperature that the cells can withstand. Without injurious effect.**
	a. Continuously. b. Short periods (duration to be stated along with temperature).
27	Maximum number of charge / discharge cycles that the cell can withstand.
28	Ampere-hour efficiency at ten-hour discharge rate.
29	Watt-hour efficiency at ten hour discharge rage
30	Estimated life of cell under normal operating conditions (in years) % change in life of battery for change in ambient temperature 27 degree centigrade.
31	a. Maximum short circuit current per battery. b. Allowable duration of short circuit.
32	**Short circuit current for a dead short across the Battery terminals when.**
	a. Float at 2.1V per cell b. Boost charge to 2.75 V per cell.
33	Recommended floating voltage per cell and the Minimum variation.
34	Recommended interval at which battery should be Discharged at 10 hour rate and quick charged.
35	Recommended storage period of a fully charged battery.
36	**Inter cell connector.**
	a. Inter-cell connector furnished ? (Yes/No). b. Type of inter-cell connector (bolted or others)? c. Materials of inter cell connector.
37	Inter-row, inter tier connectors and end take- off furnished? Description. Size current rating type and material
38	**Battery stack / rack.**
	a. Outline dimensions. b. Type and material. c. Anti-acid coating type. d. Number of trays. e. Height of bottom tier from ground level. f. No. of cells which can be stacked in tray. g. Dimensions of each tray.
39	Total shipping weight of battery units.
40	A dimensional layout drawing of the battery stock / rack along with battery attached with the tender (yes /No)
41	**The following characteristic curves to be furnished along with the tender (yes/No).**
	a. Battery discharge curves at various rates between 1 minute and 10 hour rate. b. Curves showing the relation between the cell voltage and charging current, when charged at:
	14. Finishing rate. (ii) High starting rate. (iii) Two step charging by starting and finishing rate.

PART – B
CHARGER FOR PLANTE BATTERIES

B.1 BRIEF DESCRIPTION

Charging equipment comprising of a **float charger and a Float cum boost & Float Cum Boost Charder suitable for 48 V Battery Type VRLA for Telecommunication Purpose)** charger, is required to meet the D.C. power requirements of the sub-station under normal conditions, i.e., when AC auxiliary power supply is available and also to keep all the cells in the state of full charge. The float charger shall supply the continuous DC load at the bus bars in addition to keeping, the plante batteries floated in a healthy condition. In case of failure of A.C. mains or sudden requirement of additional DC power, the battery shall meet the demand as the battery shall be connected in parallel with the charger. After the battery has discharged to a considerable extent, it shall be fully recharged by the 'boost' charger unit in a short period so as to prepare it for the next emergency. Even during the 'boost' charging of the battery, the continuous DC load at the bus shall be met by the trickle-charging unit. The 'boost' charging unit shall however be provided with suitable control arrangement to function as a stand-by for float charging unit in case of necessity.

B.2 ARRANGEMENTS :

B.2.1 Trickle (Float) Charger :

The trickle charger shall have arrangement for regulation of D.C. output voltage by:-

(i) automatic voltage regulation system.

(ii) Shall be of thyristor control type with both 'auto/manual' control arrangement.

B.2.2. Quick (Boost) Charger :

The quick charger shall be similar type as trickle charging equipment, but shall have the following features.

(i) Shall be of higher capacity to deliver D.C. output, as stipulated in this specification for quick charging of the plante batteries.

(ii) Shall be provided with control arrangement for 'auto/manual' current regulation features, necessary for quick charging

(iii) Shall also have 'auto/manual' voltage control arrangement for use when the charger will be utilised as a trickle charger.

B.3. The 'Trickle' and 'Quick' charger shall be self supporting cubicle type with front panels hinged and suitable for mounting instruments, incoming A.C., circuit breaker with thermal and instantaneous releases relays, contactors and control switches etc. The panels shall have access from the backside also. These cubicles shall also house transformers, rectifiers and other equipment's, accessories, as stipulated in this specification.

B.4 DESIGN AND CONSTRUCTION DETAILS:

B.4.1 The 'trickle' charger and 'quick' charger shall be complete with silicon controlled rectifier units, dry type air-cooled transformers, control electronics, smoothing filters etc. suitable for operation from 415V $\pm$ 10%, 50 HZ $\pm$ 5%, 3 phase A.C. supply. The charger output shall be stabilized to $\pm$ 1% of set value for $\pm$ 10% input voltage variations and 0-100% load variation.

B.4.2 The battery charger shall have full-wave, Half-controlled thyristor controlled bridge rectifier circuit. The charger output voltage shall suit the battery offered. The float voltage shall be adjustable from 80% to 115% of nominal voltage. The boost voltage shall be adjustable from 80% to 135% of nominal voltage. Ripple voltage shall be less than 3% RMS voltage.

B.4.3 Each float charger shall be capable of floating each cell of the battery bank at the specified voltage and supplying specified float current continuously under normal system operation.

B.4.4 Under normal operation, the float charger shall be supplying the DC load current and at the same time trickle charge the station battery. When the battery voltage goes down considerably, automatic transfer arrangement shall be provided such that the battery is disconnected from the float charger and gets connected to the boost charger. However, when battery is on boost charge, DC load shall be fed from the float charger. In addition, means shall be provided to ensure interruption free availability of control power from the battery whenever there is a power failure irrespective of whether the battery is on boost charge or float charge.

B.4.5 The selection of electronic components shall be used on ambient temperature of 50 degree C. and shall be of worst-case design to ensure continuous and trouble

free service. The control electronics shall be built on plug in type glass epoxy printed circuit boards of modular design.

B.4.6 The maximum temperature, attained by any part of trickle charger and quick charger, when in service at site under continuous full load conditions shall not exceed the permissible limits as fixed by relevant standards and as corrected to site condition.

B.4.7 Charger Panel :

B.4.7.1 Charger panels shall be rigid, self supporting structures, completely assembled and totally enclosed cubicle type construction, made out of structural steel members with sheet steel-coverings.

B.4.7.2 The enclosure of the charger shall be made of CRCA sheet steel of thickness not less than 2 mm for load bearing members, 1.6mm for door and non-load bearing members and 3 mm for gland plates. Panels shall be offered with base frame of 3.0 mm thick CRCA sheet, painted black all around, suitable for bolting/ welding/ grouting on to the foundation. Gaskets on doors and inter panel gaskets shall be of neoprene rubber.

B.4.7.3 The panel shall have hinged front and back doors with concealed type hinged locks and latches.

B.4.7.4 The panel shall have adequate cross -ventilation arrangement to avoid any undue rise in temperature.

B.4.7.5 All equipment’s and wiring used in the panel shall be tropicalised dust proof and vermin-proof.

B.4.7.6 Power wiring for the chargers shall be done with 1.1KV grade, heavy duty, single core, stranded copper conductor PVC insulated cables or suitable sized PVC sleeved copper bus bars. Control wiring for the charger shall be done with 1.1 KV grade PVC insulated copper wires of cross section 2.5 sq. mm for all control connection. Wire of 2.5 sq. mm cross section shall be used for control bus. All control wiring shall be ferruled.

B. 4.7.7 Necessary terminals for grounding the panel with two separate earthings shall be arranged for bottom entry and suitable cable glands shall be provided for the cables.

B.4.7.8 Each charger panel shall incorporate all the necessary controls, Indications, interlocks, protective devices and timing features to ensure any operation.

Provision shall be made with necessary contact / relays for annunciation in the event of alternating current power failures to the charger and automatic shut down of the charger by over-voltage / current devices. Annunciation shall however be prevented when the charger is manually shutdown or when A.C. power supply is momentarily interrupted for adjustable period of 1 to 5 seconds.

B.4.7.9. The float and equaliser charging rates shall both be adjustable from the front of the charger control panel. Each charger shall be protected against any damage from over voltage/ load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device for abnormal conditions of low battery voltage down to 175V (80%) of the rated voltage). But the chargers shall be disconnected from A.C. input supply through an over-voltage relay, if the input voltage exceeds 10% of the rated voltage of the equipment. Necessary selector switches for 'Trickle Charging' and 'Quick charging' shall be provided. There shall be 'make before break' type blocking Diodes and other equipments to be shown in the drawing or otherwise found necessary for charging or otherwise found necessary for charging the battery without increasing the voltage beyond safe value across the load shall also be supplied by the tenderer.

B.4.8 The rectifier units of the chargers shall be capable of supplying an impulse load of 6/7 times its rated capacity. The trickle charger in conjunction with automatic voltage regulators shall have drooping characteristics, So as to transfer the load beyond its capacity to the battery.

B.4.9 The incoming and outgoing circuits shall be provided with MCCBs with static releases for overload, short circuit and earth fault protections. The incoming power supply to the chargers will be from two sources with a facility of changeover switch. The change over facility shall be provided in the charger itself.

B.4.10 The battery circuit shall be provided with HRC fuse protection over a suitably rated load break isolator switch and reverse protection circuits.

B.4.11 Input volt meter and ammeter shall be of moving iron type and shall be 96 x 96 mm. Square. These meters shall be of accuracy class not less than 1.0 and shall be of flush mounting type with required PTs and CTs and selector switches. Output voltmeter and ammeter shall be moving iron type and shall be 96 x 96 mm square. The meter shall be of accuracy class not less than

1.0 and shall be flush mounting type. The ammeter shall be centre zero type for measurement of charging and discharging current from the battery.

B.4.12 Cluster LED lamps for indicating 'Input on' condition and 'Output on' condition, float status on / off, boost status on / off etc. shall be provided. Annunciation with audiovisual alarms shall be provided for the following.

- Input mains failure.
- Input phase failure.
- Input fuse failure.
- Rectifier fuse failure.
- Filter fuse failure
- DC over voltage
- DC under voltage
- Output fuse failure
- Charger over-load
- Earth leakage
- Alarm supply fuse failure
- Charger trip
- Output MCCB tripped
- AC under voltage
- Battery low condition

ACCEPT, TEST AND RESET push buttons shall be provided. 20% spare annunciation windows shall be provided.

B.4.13 : Any other item(s), not stipulated in this specification, but required for installation, operation and maintenance of the battery charger is / are included in the scope of supply without any extra charge on OPTCL.

B.5 TRANSPORT : The chargers alongwith its accessories shall be suitably packed and transported to site in ready to use condition.

B.6 TESTS

B.6.1 Type Tests : The bidder shall submit the test reports alongwith his offer for the following type tests conducted on the offered samples (both float charger and boost charger) as per relevant National Standard (s) within five years from the date

of opening of the bid and test-witnessed by any Government Department /Government undertaking, failing which the offer is liable for rejection.

(a) Measurement of voltage regulation / AVR regulation

(b) Efficiency and power factor measurement test

(c) Temperature rises test so as to determine the temperature rise of SCR, Transformer primary, Secondary and core, Diode, capacitor, choke and cabinet etc.

(d) Measurement of insulation resistance.

i) AC input to earth.

ii) AC input to DC output.

iii) DC output to earth

(e) Test for rectifier transformer.

(f) DC voltage current characteristic

(g) High Voltage Tests.

(h) Determination of regulation

(i) Measurement of ripple

(j) Reverse leakage test.

B.6.2 Acceptance Tests : Followings shall constitute the acceptance tests which shall be tested by the purchaser's representative at the works of the manufacturer at the cost of the supplier (both for FC & FCBC) for each charger. No sampling is allowed.

(a) Measurement of voltage regulation / AVR Regulation

(b) Efficiency and power factor measurement

(c) Temperature rise test so as to determine the temperature rise of SCR, Transformer primary, secondary and core, diode, capacitor, choke and cabinet etc.

(d) Measurement of insulation resistance.

(1) AC input to earth

(2) AC input to DC output

(3) DC output to earth

(e) Test for rectifier transformer (all relevant tests as per corresponding ISS)

(f) DC voltage current characteristic

(g) High voltage tests.

(h) Determination of regulation.

(i) Measurement of ripple

(j) Tests for indications and alarms as per this specification

(k) Tests for indicating instruments.

(l) Determination of system set points.

(m) Soft start test

N.B. : The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipment's are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates, vendor's test certificates for different equipment's, accessories, instruments etc. shall be submitted, whenever required by the purchaser.

B.7. **DRAWINGS / DOCUMENTS**

The tenderer shall submit the following drawings / documents alongwith his offer failing which the offer is liable for rejection.

(a) OGA of the battery chargers

(b) General layout with overall dimensions

(c) Electrical schematic diagram showing connections and controls.

(d) Leaflets and technical literature giving detailed information of the panels offered.

The manufacturer shall submit the following drawings / documents in 7 (seven) copies within 15 (fifteen) days from the date of issue of the purchase order for purchaser's approval.

(a) OGA of the battery chargers

(b) General layout with overall dimensions marked alongwith sectional views showing cable entry position etc.

(c) Rating calculations for transformer, rectifiers, diode, capacitor, inductor etc.

(d) Detailed schematic and connection and control wiring diagram for all the equipments.

(e) Complete bill of materials

(f) Technical excerpts on operation.

(g) The circuit diagram of charger including circuit diagrams of all cards to facilitate the maintenance of chargers

B.8 SPECIAL TOOLS, PLANTS AND SPARES

The tender shall quote for recommended special tools, plants and spares, considered necessary for installation and maintenance of batteries and charges for a minimum period of 5 (five years.)

The following mandatory spares are to be quoted by the bidder in the price bid:-

a) Voltage regulator cards- 1 No/Charger.

b) protection card (if any)- 1 No/ Charger.

c) Thyristor (SCR)- 2 Nos. for F.C.+ 2 Nos. for B.C./ Charger.

d) Rectifier Diode- 2 Nos. for F.C,+ 2 Nos. for B,.C./Charger.

e) Blocking Diode- 1 No. for F.C. + 1 No. for B.C./ Charger.

f) Filter Capacitor- 1 Set/Charger.

g) Auto-manual switch- 1 No. for F. C. + 1 No. for B.C./ Charger.

h) Indicating LED- 10 Nos./Charger

i) Indicating fuse (if any)- 10 Nos./Charger

j) Input A.C. contactor- 1 No. for F.C,. + 1 No. for B.C./ Charger

k) Rectifier H.R.C. fuses- 4 Nos. for F.C. + 4 Nos. for B.C./Charger.

B.9 GUARANTED TECHNICAL PARTICULARS

The guaranteed technical particulars of this specification shall be furnished alongwith the tender. Any tender, lacking complete information in this respect is likely to be rejected.

B. 10 DEVIATION FROM SPECIFICATION

All deviations from the specification shall be separately listed in the technical deviation sheet, in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer.

B11. GENERAL TECHNICAL REQUIREMENTS FOR BATTERY CHARGER SUITABLE FOR 220 V/48 V LEAD ACID PLANTE BATTERY

1	Type	Float & Float cum boost charger for 220 V & Float Cum Boost Charger for 48 V DC full wave, full controlled type.	
2.	RATINGS	>220V : 350 AH Plante Battery: 35A/60A Float & Float cum Boost Charger. >48V : 350 AH & 550 AH Plante Battery: 35A/70A & 50A/100 : Float cum Boost Charger. >220 V : 645 AH Plante Battery:70/100 A Float & Float cum Boost Charger.	
3.	AC INPUT (a) Voltage (b) Frequency (c) Phase	 415VAC ± 10% 50Hz ± 5% 3-phase-4 wire	
4.	D.C.OUTPUT VOLTAGE SETTINGS Nominal Float	FC 220V/48V 253V/54.5V (adj. By + 20%, - 5%	BC 220V/48V 302V/66.5V (adj. By + 2%, - 5%)
5.	OUTPUT CURRENT LIMIT	35A 60A (for 350AH) 70 A 100A(for 645AH) 70 A for 48 V,350 AH	
6.	POWER CONVERSION	AC to DC by means of three phase full wave, Half controlled bridge rectifier consisting of thyristors and diodes.	
7.	VOLTAGE REGULATION AT BRIDGE OUTPUT.	± 1% of set value for ± 10% Input Voltage Variations, 0-100% Load variation.	
8.	RIPPLE VOLTAGE	Less than 3% RMS without battery connected.	
9.	EFFICIENCY	More than 75% at full load	
10.	PROTECTIONS		
	(a) Input side	AC input MCCB with input ON/OFF switch and fuses, contactor (for source-1&2 with interlocking)	
	(b) Output side	DC output MCCB with output ON/OFF switch and fuses contactor.	
	(c) Protection	Current limit protection, soft start feature, surge suppressor. Fast semiconductor fuses for rectifier bridge.	
	(d) control circuit	Fuses	
	(e) Capacitor	Rectifier HRC fuses.	

	circuit		
	(f)	Over-voltage cut-back	
	(g)	Charger over load / short circuit	
	(h)	Blocking diode	
11.	CONTROLS AND SWITCHES	Followings controls and switches are provided in the system a) AC input source MCCBs with interlocking b) DC output MCCB c) Auto/Manual float/boost mode selector switch. d) Float and boost voltage variable potentiometers. e) Manual voltage adjustment Potentiometer f) Test push button g) Reset push button h) Battery current adjustment potentiometers i) Heater's power supply switch j) Socket power supply switch	
12.	FEATURES	The following features are provided in the systems: a) Soft start on DC side b) Class-F insulation for all magnetic c) Automatic voltage regulation. d) Automatic changeover from float to boost and vice versa based on current, drawn by battery. e) Filter circuit to eliminate ripple. f) Charger current limit g) Separate battery path current limit. h) Built-in auto phase reversal of operation.	
13.	Meters	F.C. (i) Input Voltmeter (ii) Input Ammeter (iii) Output Voltmeter (iv) Output Ammeter	B.C. (i) Common (ii) Input Ammeter (iii) Output Voltmeter (iv) Output Ammeter.
		Battery volt meter Battery ammeter Earth leakage ammeter	
14.	Indications	(i) R,Y,B Phase 'ON' lamps (ii) Output 'ON' lamp	(i) R.Y.B. phase 'ON' lamps (ii) Output 'ON' lamp. (iii) Charger 'ON' float LED (iv) Charger 'ON' boost LED.

15.	Annunciation with audiovisual alarms.	(i) AC input mains failure (ii) Input phase failure (iii) AC under voltage (iv) Input phase failure	

		(iii) Rectifier fuse failure (iv) Output fuse failure (v) Filter fuse failure (vi) DC under voltage (vii) DC over voltage (viii) Charger trip (ix) Capacitor fuse fail (x) Output MCCB tripped (xi) Charger over load (xii) Earth leakage (xiii) DC earth fault (xiv) Alarm supply fuse failure (xv) Battery low condition.	v) Rectifier fuse failure vi) Output fuse failure vii) Filter fuse failure viii) DC under voltage ix) DC over Voltage x) Charger trip xi) Capacitor fuse fail xii) Output MCCB tripped.
Note : All the alarms shall be provided through electronic display cards. Audio alarm through buzzer, visual indication through 10 mm LEDS & alarm ackn. / reset and LED provision is through push buttons.			
16.	Operating ambient temperature surrounding the panel	0^0 to 50^0C	
17.	Surrounding the panel Relative humidity.	0-95% non-condensing	
18.	PANEL (a) Protective grade (b) Cooling (c) Paint	 (a) IP - 42 (b) Natural air-cooled (c) Smoke Grey of ISS-692 shade	
19.	MAGNETICS : (a) Average winding temperature rise over ambient temperature (b) Insulation class (c) Insulation breakdown voltage.	 As per relevant ISS. 'F' 3 KV for 1 min withstand.	
20.	CABLES	1100 V grade PVC insulated copper. Ferrules shall be provided for identification of connection.	

N.B. : - Besides the above general technical requirements, all other stipulations, as enumerated in this technical specification shall be followed. Any deviation should be clearly brought out with clear explanation.

Any extra feature/ equipment / instrument as necessary for operation and performance of the battery charger for the 220V /48 V battery set as per this specification shall be provided without any extra cost to OPTCL..

ANNEXURE – IV-A
(For Testing of Battery)
(To be filled in by the bidder)

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibr-ation	Due date of Calibration	Name of the Calibratig Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes, state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equip-ment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for corresponding test(s)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

Signature of the tenderer with seal & date

ANNEXURE – IV-B
(For Testing of Battery Charger)
(To be filled in by the bidder)

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibr-ation	Due date of Calibration	Name of the Calibratig Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equip-ment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for corresponding test(s)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

Signature of the tenderer with seal & date

ANNEXURE V – A
(To be filled in by the bidder)
CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape alongwith drawings etc. furnished or not ?	Whether the type tested Plante lead acid battery fulfills the technical requirements as per TS	If the type tested battery does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	2	3	4	5	6	7	8	9

Signature of the tenderer with seal & date

ANNEXURE V – B

(To be filled in by the bidder)
CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY CHARGER

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape alongwith drawings etc. furnished or not ?	Whether the type tested battery charger fulfills the technical requirements as per TS	If the type tested battery charger does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	2	3	4	5	6	7	8	9

Signature of the tenderer with seal

ODISHA POWER TRANSMISSION CORPORATION LIMITED

JANPATH, BHUBANESWAR – 751022

TECHNICAL SPECIFICATION

FOR

MF-VRLA BATTERY SET

I- BATTERY SETS- **48 Volt, 200 AH:-**

48 Volt, 300 AH:-

48 Volt, 400 AH:-

48 Volt, 500 AH:-

48 Volt, 680 AH:-

384 Volt, 200AH:-

PART – A

TECHNICAL SPECIFICATION

FOR

48 VOLT & 384 VOLT MF-VRLA STORAGE BATTERY

A.1.0. **SCOPE:-**

A.1.1. This specification covers the design, manufacture, assembly, shop testing at manufacturer's works before dispatch, supply and delivery at site, erection, testing and commissioning of 48 volt 200, 300, 400, 500 & 680 AH and 384Volt 200AH MF- VRLA storage batteries along with the required accessories and fittings etc.

A.1.2. It is the intention of the purchaser to install the most up to date type of equipment conforming to modern practices.

A.1.3. The scope of supply shall include all parts and accessories etc, which are usual and necessary for erection, operation and maintenance of MF- VRLA batteries as specified, though not individually and specifically stated or enumerated.

A.2.0. **STANDARDS:-**

A.2.1. All equipment and their accessories, covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards, published by the Bureau of Indian Standards including those, listed at Clause 2.6 in order that specific aspects under Indian climatic conditions are taken care of.

A.2.2. The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards, published by any other recognized National Standards Institution and latest publication of International Electro Technical commission [IEC].

A2.3. The equipment manufactured according to any other authoritative national / international standard, which ensures an equal or better quality than the provisions of these specifications shall also be acceptable. Where the equipment, offered conform to any other standard, salient points of differences between the proposed standard and the provisions of these specification shall be clearly brought out in the tender. A copy of such standards [in English] shall be enclosed with the offer.

A.2.4. The equipment shall conform to the Indian Electricity Rules, 1956 with latest amendments as regards safety earthling and other essential provisions specified therein for installation and operation of electrical plants.

A.2.5. All equipment shall also comply with the statutory requirements of the Government of Orissa where the equipment will be installed. Nothing shall be construed to relieve the supplier of his responsibility.

A.2.6. **GOVERNING SPECIFICATION:-**

The MF-VRLA batteries shall unless otherwise specified, conform to the following standards. The firms are requested to furnish the following specifications for our further reference.

i	IS-1651/1991	Specification for stationary cells batteries, leads acid type.
ii	IS-1885 [Part-8] / 1986	Electro technical vocabulary: Part- 8-Secondary cells & batteries.
iii	IS-266/1977	Sulphuric acid
Iv	BS-46290 (Part-4) / 1997	British standard specification for lead acid type valve regulated sealed type batteries.
v	ANSI, IEEE STD 450/1987	IEEE recommended practice for maintenance, testing and replacement of large lead storage batteries for generating stations and sub-stations.
vi	IEC 896-2/1995	Stationary lead-acid batteries, general requirements and methods of test (part-2, valve regulated types)
vii	IS-(1146 / UI-94) / ASTM - d - 29863	Plastic container for lead acid storage batteries.
viii	IS-3136-1965	Specification for polycrystalline semiconductor rectifier equipment
ix	IS-1248-1968	Specification for direct acting indicating analogue electrical measuring instruments and tier accessories. (Part - I)-1983-General Requirements. (Part - II)- 1983 - Ammeters & voltmeters. (Part-III)-1984-Accessories.
x	IS-2208-1962	Specification of HRC Cartridge fuse link up to 650V
xi	IS-2959-1966	Specification of contractors for voltages not exceeding 1000V AC or 1200V DC
xii	IS-3395-1966	Specification for monocrystalline semiconductor rectified cells and stacks.
xiii	IS-4540-1968	Monocrystalline semiconductor rectifier assemblies & equipment
xiv	IS-2147/1962	Degree of protection provided by enclosure for low voltage switchgear and control gear
xv	IS-5578/1984	Guide for marking of insulated conductors.
xvi	IS-8623/1993 [Part 1 to 3]	Low voltage switchgear and control gear assemblies.
xvii	IS-11171/1985	Dry type power transformers.
xviii	IS-11353-1985	Guide for uniform system of marking and identification of conductors and apparatus
xix	IS-13947-1993 (Part 1 to 5)	Low voltage switchgear and control gear

A.3.0. **OTHER REQUIREMENTS:-**

A.3.1 **ACCESSIBILITY AND INTER CHANGEABILITY:-**

BATTERY: Easy installation and handling and easy cell replacement. Batteries should be compact and can be used in any orientation without any leakage or spillage of electrolyte

A.3.2. **QUALITY AND WORKMANSHIP:-**

Workmanship and materials shall be of good commercial quality, suitable for the purpose, intended and in accordance with the highest standards and practices for equipment of the class, covered by this specification.

A.3.3. **SAFETY**

A3.3.1. All equipment shall be complete with approved safety devices wherever a potential hazard to personnel exists and with provision for safe access of personnel to and around the equipment for operational and maintenance functions. The design shall include all necessary precautions and provisions for the safety of operating and maintenance personnel.

A3.3.2. There should be no emission of corrosive fumes or gases under normal operating condition in case of Battery.

A3.3.3. Special care shall be taken to make enclosed equipment proof against entry of rat, lizards and other creeping reptiles, which may create electrical short circuits inside, live equipment.

A.3.3.4. Continuity of power supply is the first consideration and the design shall be such as to provide facilities to simplify inspection, testing maintenance, clearing and repair at site.

A.3.4. **SPECIAL SITE CONDITIONS:-**

A.3.4.4. The equipment with their accessories shall be designed for smooth, efficient and trouble free operation in tropical humid climate for maximum temperature of 50 degree C and maximum humidity of 98 percent. Maximum temperature and maximum humidity are however not likely to occur simultaneously. De-rating of equipment shall be done for an ambient temperature of 50 degree C.

A.3.5. **PAINTING:-**

All items of equipment and materials shall be thoroughly cleaned and painted in accordance with IS Specification.

A.4.0. **CONSTRUCTIONAL DETAILS OF MF- VRLA BATTERY.**

A.4.1. **PLATES**

Positive plates shall be made of flat pasted type using Lead-calcium-tin alloy for durability, low corrosion, maintenance free, low self-discharge rates and long life both in cyclic as well as in the float applications.

Negative plates shall be heavy duty, durable flat plate using lead-calcium-tin alloy grid. Negative plates shall be designed to match the life of positive plates and combination of positive and negative plates shall ensure long life, durability and trouble free operation of the battery. PLC Operated equipment should be deployed for preparation of plate to ensure consistency in plate quality. Conventional / manual type of plate preparation is not allowed.

A.4.2. **SEPARATORS:-**

The separator shall be absorptive glass mat type or spun glass micro porous matrix type and shall be resistant to sulphuric acid. It shall be capable of keeping all the electrolyte and shall be electrically insulated. Sufficient separator overlap and PVC shield protection to top and bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates. The uncompressed water absorption of the separator shall be at least 5 gm. of water / gm of separator material.

A.4.2.1. **REQUIREMENT OF WICKING TEST ON SEPARATORS:-**

The total wicking height shall not be less than635 mm in 24 hours. The minimum water content at 125 mm. Height shall be at least 5 gm. of water per gm. of separator. The weight of water per gm. shall be at least 90% of the value at 125 mm when checked at a height of 450 mm.

A.4.3. **VALVE:-**

Safety valve vent plugs shall be provided in each cell. They shall be explosion resistant, self-resealing and pressure regulating type. They shall not allow gas (air) to enter into the cell but shall allow gas to escape from the cell above a certain internal pressure, which does not lead to deformation or other damage to the cell.

A.4.3.1.The vent plug used shall be explosion resistant and self re-sealing pressure regulating type. Vent plug shall be such tat it cannot be opened without proper tool.

A.4.3.2.The valve shall be so designed that it operates at a pressure between 0.14 Kg / Sq. mm to 0.63 Kg / Sq. mm to release the excess gas and reseal automatically as soon as the gas pressure within the cell drops to atmospheric value.

A.4.3.3.All the cells shall be subjected to pressure test upto 0.7 Kg / Sq. mm.

A.4.3.4.The self-discharge rate at room temperature shall not be more than 5 % of the capacity of each battery per month.

A.4.3.5.Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

A.4.4. **CONTAINERS AND LID:-**

A.4.4.1.The container shall be made up of a special grade polypropylene copolymer material, which should be of flame-retardant.

A.4.4.2.The container shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range, naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapor permeability.

A.4.4.3.The container shall be enclosed in epoxy coated steel trays. The steel trays shall be so designed as to make both vertical and horizontal

stacking of cells / batteries possible.

A.4.5. **LIDS / COVERS:-**

Sealed maintenance free batteries shall have polypropylene copolymer covers. The complete container along-with lid / cover shall be able to withstand without fracture for 5 hours at 25 degree Celsius at an internal pressure of 5 times the normal operating pressure. The complete design includes the pillar to lid seal, which shall be designed to remain gas-tight and electrolyte-tight during the designated life of the battery.

A.4.6. **PILLAR SEAL ASSEMBLY:-**

A.4.6.1.The pillar to lid seal shall be designed to remain gas-tight and electrolyte-tight during the designated life of the unit. The terminal shall conform to Class 3.2 of BS: 6290, Part - 4 -1987.

A.4.7. ELECTROLYTE:-

The electrolyte shall be prepared form the battery grade H_2SO_4 conforming toe ISS:266. The batteries shall be supplied in factory filled charged condition. All the acid will be in immobilized condition the AGM separator.

A.4.8. WATER:-

Water required for preparation of electrolyte shall conform to IS:1069.

A.4.9. CONNECTORS AND FASTENERS:-

Lead or lead coated copper connectors shall be used for connecting up adjacent cells and rows. The thickness of lead coating of connectors should be not less than 0.025 mm. The lead coating thickness shall be measured in accordance with APPENDIX-F of IS : 6848 : 1979. All the terminals and cells inter connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative and poles of batteries shall be made by single core cable having stranded aluminum / copper conductors and PVC / XPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the supplier. All connectors and lugs shall be capable of continuously carrying the 30 minute discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Bidder shall furnish necessary sizing calculations to prove compliance to the same.

A.4.10. PLATE CONNECTIONS:-

Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be casted with lead alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

A.4.11. NUT & BOLTS:-

Nuts and bolts for connecting the cells shall be made of copper, brass or superior grade passivated stainless steel which should be resistant to sulphuric acid. Copper & brass shall be coated / plated with suitable materials such as Nickel / Chrominium to prevent sulphation or corrosion.

A.4.12. **TERMINALS:-**

Terminals shall be of integral lead terminal with solid copper core with M6 threading for fastening. The junction between terminals posts and cover and between the cover and container shall be hermetically sealed.

A.4.13. **SEAL:-**

a) TIG welding shall be done for post sealing.
b) Additional Epoxy resin sealing shall be provided for double assurance against leakage.

A.4.14. **SUPPORTING RACKS:-**

Batteries shall be installed on MS racks **to be supplied by the supplier** to fit in the battery /battery charger room. Racks / trays shall be powder coated with anticorrosive paint and supplied in unassembled state. Rack / tray shall be subjected to 7 tank process before painting for protection against fungus growth and other harmful effect due to tropical environment.

The steel trays / containers shall be stackable one over the other horizontally in multi-tier arrangement. The bottom most tray shall be mounted on I-channels with 150 mm height. The positive and negative terminals shall be terminated onto the terminal plate assembly, which is fitted to one of the steel tray depending on the convenience at site.

A.4.15. **MARKING:-**

The following information shall be legibly laid durably marked on each cell battery:-

(a) Nominal Voltage.

(b) Name of the manufacturer and type reference.
(c) Rated or nominal capacity expressed in ampere hour (AH) with an indication of the rating expressed either as a current or as time together with the relevant final voltage of each cell.
(d) Voltage for float operation 27^0 C with tolerance of 1%.
(e) Cell number.
(f) Type of positive plate.
(g) Type of container.
(h) Date of manufacture (month and year) or (week and year).

A.5.0. **MAXIMUM SHORT CIRCUIT CURRENT:-**

The bidder shall state the maximum short circuit current of each battery along-with the safe duration in seconds, which it can withstand. Complying with clause 5.5 of IEC – 896 – 2/1995. Method proposed to be adopted for protecting batteries from the short circuit conditions should also be stated to avoid damage to the battery and loss to the associated equipment.

A.6.0. **VENTILATION:-**

The Bidder shall indicate in his bid the requirements of ventilation in the battery room. The battery shall operate satisfactory over the entire range of temperature indicated in this specification without affecting its normal life. Bidder shall indicate the percentage reduction in battery capacity at the lowest temperature of 27 Degree C. If any special ventilation requirements are necessary, the same shall be indicated.

A.7.0. **CAPACITY:-**

The standard Ampere-hour capacity at ten hour rate shall be 200, 300,400, 500 and 680 AH to end cell voltage of 1.75 volts /cells as per IS 15549/2005.

A.7.1. **SELF DISCHARGE RATE OF BATTERY:-**

Self discharge rate shall be less than 0.5 % of C 10 Capacity per week at 27 degree C.

A.8.0. **CHARGING:-**

The bidder shall state whether an equalizing charge is recommended for the battery. If so, the equalizing charge voltage, current, duration and the interval between the equalizing charging shall be specified in the Data Sheet. Bidder shall also indicate the requirements for boost charging.

A.9.0. **LIFE:-**

The bidder shall quote in his offer the guaranteed life of the battery, when operating under the conditions, specified. The bidder shall also quote the change in life of the battery due to change in temperature form 27 degree centigrade in the event the batteries are required to be operated under higher temperature environment.

A.10.0. **DESIGN VALIDATION:-**

Over the range of manufacturer's capacity, at least one capacity should have been tested and should meet the requirement of Service Life as per ANSI TI : 330 Specification. Necessary evidences maybe enclosed along-with the offer.

A.11.0. **MAINTENANCE TOOLS & INSTRUCTION:-**

A.11.1. Two sets of operation & maintenance manuals along with each set of battery shall have to be furnished.

A.11.2. It is mandatory for the bidder to provide with the spare relating to the batteries including cells for replacement for a minimum period of 8 years.

A.12.0. **ELECTRICAL CHARACTERISTICS:-**

DESIGN SHOULD ENSURE THAT:-

(a) Battery shall be suitable for constant current constant voltage charging.
(b) Nominal float voltage shall not exceed 2.25 V per cell @ 27 degree C.
(c) Recharging shall be done at normal float voltage.
(d) Charging current shall not exceed 0.15 C. Where C is the capacity in AH @ 10 hours of discharge to end cell voltage 1.80 V @ 27 ^{0}C.
(e) Except during commissioning. Battery shall not demand boost charging at any point of time during its operation.
(f) Battery shall not demand equalizing charge at any point of time during its operation.

A.13.0. **PROCESS REQUIREMENT:-**

(a) 100% cells shall be tested by Helium ion leak tester for leak free performance. Vendor shall attach a copy of the Helium ion tester report along with the dispatch documents.

(b) Vendor is expected to monitor the voltage and current data of the cells during initial charge and test discharge by means of automatic data logging for traceability. Vendor shall maintain the database of the same and provide the document to the company as and when called for.

A.14.0. **TESTS**

A.14.1. **TYPE TESTS:-**

The bidder shall submit the test reports along with his offer for the following type tests, conducted on the offered samples as per relevant National Standard (s) within five yeas from the date of opening of the bid and test witnessed by any Government Department / Government undertaking failing which the offer is liable for rejection.

(a) Verification of constructional requirements.
(b) Verification of dimensions /weight.
(c) Test for capacity.
(d) Test for charge retention.
(e) Endurance test.
(f) Ampere-hour and watt-hour efficiency test.
(g) Test for voltage during discharge.
(h) Test for endurance under short circuit conditions.
(i) Test for gas recombination efficiency.
(j) Wicking test Separators.
(k) Service Life test as per ANSITI : 330 Specification.

If the type test report (s) does / do not meet the requirements as per this specification. OPTCL at its discretion may ask the supplier to conduct the above type test (s) at the supplier's cost in the presence of OPTCL's representative without any financial liability to OPTCL.

A.14.2. **ROUTINE TESTS:-**

All the routine tests, listed below shall be carried out on all the cells, containers. Hardware being supplied as per latest issue of BS : 6290, Part – 4. IE C89-I or IEEE – 1188 (whichever is applicable) at the cost of the supplier.

(a) Container

(i) Verification of constructional requirements.
(ii) Verification of marking and packing.
(iii) High voltage tests (Cl : 7.6 of IS : 1146).

(b) Cells and batteries:-

(i) Verification of constructional requirements.

(ii) Verification of markings.
(iii) Verification of dimensions.

A.14.3.0. **ACCEPTANCE TESTS:-**

Followings shall constitute the acceptance tests which shall be test-witnessed by Purchaser's representative at the works of the manufacturer at the cost of the supplier.

1. Verification of dimensions.
2. Verification of marking.
3. Tests for capacities for 10 hours discharge rate along with the test for voltage during discharge.
4. Ampere-hour and watt-hour efficiency test.
5. Short circuit current test of batteries (arrangement for this shall be provided
6. during testing).
7. Resistance of cell / batteries.
8. Pressure of vent plug connected with battery (measuring shall be provided during testing).
9. Measurement of weight / material type and dimension of cell / racks / batteries and all other accessories as per approval of drawings / technical data submitted during tender process. All these shall be submitted in detail with the submission of tender paper.

A.14.3.1. The purchaser may at his discretion undertake test for capacity and voltage during discharge after installation of the battery at site without any extra cost.

A.14.3.2. The supplier shall arrange for all necessary equipments, including the variable resistor, tools, tackles and instruments. If a battery / battery charger fails to meet the guaranteed requirements, OPTCL shall have the option of asking the supplier to replace the same.

A.15.0. **DRAWINGS / DOCUMENTS:-**

The tenderer shall submit the following drawings documents along with his offer failing which the offer is liable for rejection.

(a) General battery arrangement including proposed size of individual and over all dimensions along with sectional views showing all connections etc.
(b) Pamphlets and technical literature giving detailed information of the batteries offered.

The manufacturer shall submit the following drawings / documents in duplicate within (fifteen) days from the date of issue of the purchase order for purchaser's approval.

(a) Layout details of the batteries with all accessories.
(b) OGA Cross-sectional details for battery cells.
(c) Instruction manuals for initial charging and subsequent charging.
(d) Technical data, characteristic curves etc.

A.16.0. TRANSPORT:-

The charged batteries, accessories and racks shall be suitably packed and transported to site in ready to use condition.

A.17. All deviations from the specification shall be separately listed, in the absence of which it will be presumed that the provisions of these specifications are complied with by the bidder.

ANNEXURE -1

SPECIFICATION FOR 48 Volt 200, 300, 400, 500 & 680 AH and 384 Volt, 200AH MF-VRLA BATTERY

SL. NO.	SPECIFICATION	CONFIRM / NOT CONFIRM
1	Maintenance free valve regulated sealed type Lead acid battery 48Volt/ 200,300,400, 500 and 680AH. 2V per cell [Total 24 Nos. battery cells/set] and 384Volt,200AH, 2V per cell [Total 192 Nos. battery cells/set]	
2	The cells should be assembled in stack over insulated steel rack to make 48 Volt / 200,300,400,500 & 680AH and 384Volt, 200AH battery set for communication system.	
3	The steel rack will be placed over porcelain. Hard rubber insulator of 100 mm Height [approx.] to minimize leakage current to ground	
4	All the battery cells are to be assigned with number	
5	The final positive and negative terminals are to be brought to the terminal plate assembly (TPA). Suitable arrangement should be made for terminating the cables at the TPA	
6	Test for capacity of batteries should conform to IS: 15549/2005	
7	The battery should be supplied with all accessories like connectors, links, S.S. nuts. Bolts and insulator etc.	
8	All the portion of connectors and adjacent steel plates are to be sleeved and insulated.	
9	Discharge test of batteries at 10 hr. rate of discharge to end cell voltage of 1.75 volt per cell to conform to the requirement of IS : 15549/2005 should be carried out by the supplier at the works of manufacturer and at the site. The ambient temperature at the place of installations will be considered for the calculation period of discharge.	
10	The battery should have a life expectancy of minimum 8 years at battery room ambient temperature that varies from a minimum of 20 degree centigrade during winter season and a maximum of 50 degree centigrade during peak summer. The tenderer should submit the relevant technical literature with details design, calculation graph documents etc. in support of indicated life of the battery taking care of the above seasonal ambient temperature variation.	

11	The supplier should submit the documentary evidence (P.O. copy) for supply, installation land commissioning of battery capacity of 200,300,400,500 & 680 AH or higher capacity to the communication Systems under any GRID Sub-stations/communication equipments and the same is in successful operation for a minimum period of last 2 years as on date of opening of the tender.	
12	The watt-hour and ampere-hour efficiency and internal resistance value of the battery should be furnished.	
13	The supplier should show the values of internal resistance of all the cells at the time of commissioning at site and the same should confirm to the value indicated by them in their technical bid.	
14	The procedure of charging the battery before the capacity test should be furnished. The battery set will be inspected & tested at works before dispatch to store/site.	

[To be filled in by the bidder]

ANNEXURE II

SCHEDULE OF GUARANTEED TECHNCAL PARTICULARS FOR 48 VOLT 200,300,400, 500 & 680 AH AND 384 VOLT, 200AH MF-VRLA LEAD ACID STORAGE BATTERY

(TO BE FILLED IN BY THE BIDDER)

Values / Others.

1	Manufacturer's name and address :			
2	Conforming to standards.			
3	Type and designation as per IS.			
4	Manufacturer's type and designation			
5	Capacity of battery bank at the following discharge rates at 27^0C	Cap. AH	Rate of Disch. Current	End Cell voltage
	a. 15 minutes. b. 30 minutes. c. 45 minutes. d. 1 hour e. 2 hours f. 3 hours. g. 4 hours. h. 5 hours. i. 6 hours. j. 7 hours. k. 8 hours. l. 9 hours. m. 10 hours.			
6	Number of cells in the battery.			
7	Method of interconnection between cells.			
8	Maximum short circuit current of battery when short circuit is at the end of terminals			
9.	Recommended float-charging voltage across the battery terminals (volts).			

10	Recommended boost charging voltage across battery terminals (volts).
11	Time required for boost charging from discharged conditions (in hours).
12	Recommended trickle / float charging rate
13	Recommended boost charging rate.
14	Trickle charging current range / cell.
15	Shelf life of charged battery bank.
16	Open circuit voltage of battery bank when fully charged.
17	AH capacity at 10 hours rate at room temperatures of:-
	a. 15^0C. b. 27^0C c. 50^0C
18	Cell Particulars:-
	a. Material of container. b. Overall dimensions of each cell. c. Weight of cell complete with acid.
19	**Voltage:-**
	a. Open circuit voltage of cells. b. Float charging voltage. c. Boost charging voltage.
20	Type of material / thickness / dimension of positive plates.
21	Type of material / thickness / dimension of negative plates.
22	Separators:-
	a. Type. b. Materials. c. Thickness of separator.
23	Type of valve provided.
24	Internal resistance of each cell at
25.	**Clearance in mm between.**
	a. Top of plates and top of container. b. Bottom of plates and bottom of container. c. Edges of plates and inner surface of container.
26	**Maximum ambient temperature that the cells can withstand. Without injurious effect.**
	a. Continuously. b. Short periods (duration to be stated along with temperature).
27	Maximum number of charge / discharge cycles that the cell can withstand.
28	Ampere-hour efficiency at ten-hour discharge rate.

29	Watt-hour efficiency at ten hour discharge rage
30	Estimated life of cell under normal operating conditions (in years) % change in life of battery for change in ambient temperature 27 degree centigrade.
31	a. Maximum short circuit current per battery. b. Allowable duration of short circuit.
32	**Short circuit current for a dead short across the Battery terminals when.**
	a. Float at 2.1V per cell b. Boost charge to 2.75 V per cell.
33	Recommended floating voltage per cell and the Minimum variation.
34	Recommended interval at which battery should be Discharged at 10 hour rate and quick charged.
35	Recommended storage period of a fully charged battery.
36	**Inter cell connector.**
	a. Inter-cell connector furnished ? (Yes/No). b. Type of inter-cell connector (bolted or others)? c. Materials of inter cell connector.
37	Inter-row, inter tier connectors and end take- off furnished? Description. Size current rating type and material
38	**Battery stack / rack.**
	a. Outline dimensions. b. Type and material. c. Anti-acid coating type. d. Number of trays. e. Height of bottom tier from ground level. f. No. of cells which can be stacked in tray. g. Dimensions of each tray.
39	Total shipping weight of battery units.
40	A dimensional layout drawing of the battery stock / rack along with battery attached with the tender (yes /No)
41	**The following characteristic curves to be furnished along with the tender (yes/No).**
	a. Battery discharge curves at various rates between 1 minute and 10 hour rate. b. Curves showing the relation between the cell voltage and charging current, when charged at:
	(i) Finishing rate. (ii) High starting rate. (iii) Two step charging by starting and finishing rate.

ANNEXURE – IV

(For Testing of Battery)

(To be filled in by the bidder)

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibr-ation	Due date of Calibration	Name of the Calibratig Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes, state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equip-ment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for correspondin g test(s)	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Signature of the tenderer with seal & date

ANNEXURE V

(To be filled in by the bidder)

CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape along with drawings etc. furnished or not ?	Whether the type tested Plante lead acid battery fulfills the technical requirements as per TS	If the type tested battery does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Signature of the tenderer with seal & date

ODISHA POWER TRANSMISSION CORPORATION LIMITED

JANPATH, BHUBANESWAR – 751022

SECTION – IV

TECHNICAL SPECIFICATION

FOR

SMPS BASED BATTERY CHARGERS

50 VOLT BATTERY CHARGER (SUITABLE FOR 48V MF-VRLA BATTERY) :

50 Amp-

75 Amp-

100 Amp-

125 Amp-

PART – A

TECHNICAL SPECIFICATION

FOR

50 VOLT SMPS BASED BATTERY CHARGER

A.1.0. **SCOPE:-**

A.1.1. This specification covers the design, manufacture, assembly, shop testing at manufacturer's works before dispatch, supply and delivery at site, erection, testing and commissioning of 50 volt 50A,75A,100A & 125A SMPS based float cum boost chargers.

A.1.2. Comprehensive AMC of the said commissioned Chargers for a period of 5 years beyond successful completion of guarantee period.

A.1.2. It is the intention of the purchaser to install the most up to date type of equipment conforming to modern practices.

A.1.3. The scope of supply shall include all parts and accessories etc, which are usual and necessary for erection, operation and maintenance of SMPS based chargers as specified above, though not individually and specifically stated or enumerated.

A.2.0. **STANDARDS:-**

A.2.1. All equipment and their accessories, covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards, published by the Bureau of Indian Standards including those, listed at Clause 2.6 in order that specific aspects under Indian climatic conditions are taken care of.

A.2.2. The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards, published by any other recognized National Standards Institution and latest publication of International Electro Technical commission [IEC].

A2.3. The equipment manufactured according to any other authoritative national / international standard, which ensures an equal or better quality than the provisions of these specifications shall also be acceptable. Where the equipment, offered conform to any other standard, salient points of differences between the proposed standard and the provisions of these specification shall be clearly brought out in the tender. A copy of such standards [in English] shall be enclosed with the offer.

A.2.4. The equipment shall conform to the Indian Electricity Rules, 1956 with latest amendments as regards safety earthling and other essential provisions specified therein for installation and operation of electrical plants.

A.2.5. All equipment shall also comply with the statutory requirements of the Government of Orissa where the equipment will be installed. Nothing shall be construed to relieve the supplier of his responsibility.

A.2.6. **GOVERNING SPECIFICATION:-**

The MF-VRLA batteries and the associated chargers shall unless otherwise specified, conform to the following standards. The firms are requested to furnish the following specifications for our further reference.

i	IS-1651/1991	Specification for stationary cells batteries, leads acid type.
ii	IS-1885 [Part-8] / 1986	Electro technical vocabulary: Part- 8-Secondary cells & batteries.
iii	IS-266/1977	Sulphuric acid
Iv	BS-46290 (Part-4) / 1997	British standard specification for lead acid type valve regulated sealed type batteries.
v	ANSI, IEEE STD 450/1987	IEEE recommended practice for maintenance, testing and replacement of large lead storage batteries for generating stations
vi	IEC 896-2/1995	Stationary lead-acid batteries, general requirements and methods of test (part-2, valve regulated types)
vii	IS-(1146 / UI-94) / ASTM - d -29863	Plastic container for lead acid storage batteries.
viii	IS-3136-1965	Specification for polycrystalline semiconductor rectifier equipment
ix	IS-1248-1968	Specification for direct acting indicating analogue electrical measuring instruments and tier accessories. (Part - I)-1983-General Requirements. (Part - II)- 1983 - Ammeters & voltmeters. (Part-III)-1984-Accessories.
x	IS-2208-1962	Specification of HRC Cartridge fuse link up to 650V
xi	IS-2959-1966	Specification of contractors for voltages not exceeding 1000V AC or 1200V DC
xii	IS-3395-1966	Specification for monocrystalline semiconductor rectified cells and stacks.
xiii	IS-4540-1968	Monocrystalline semiconductor rectifier assemblies & equipment
xiv	IS-2147/1962	Degree of protection provided by enclosure for low voltage switchgear and control gear
xv	IS-5578/1984	Guide for marking of insulated conductors.
xvi	IS-8623/1993 [Part 1 to 3]	Low voltage switchgear and control gear assemblies.
xvii	IS-11171/1985	Dry type power transformers.
xviii	IS-11353-1985	Guide for uniform system of marking and identification of conductors and apparatus
xix	IS-13947-1993 (Part 1 to 5)	Low voltage switchgear and control gear

A.3.0. **OTHER REQUIREMENTS:-**

A.3.1 **ACCESSIBILITY AND INTER CHANGEABILITY:-**

CHARGER: All working parts, in so far as possible, shall be arranged for convenience of operation, inspection, lubrication and case of replacement with minimum down time. All like parts of the equipment, furnished shall be inter changeable.

A.3.2. **QUALITY AND WORKMANSHIP:-**

Workmanship and materials shall be of good commercial quality, suitable for the purpose, intended and in accordance with the highest standards and practices for equipment of the class, covered by this specification.

A.3.3. **SAFETY**

A3.3.1. All equipment shall be complete with approved safety devices wherever a potential hazard to personnel exists and with provision for safe access of personnel to and around the equipment for operational and maintenance functions. The design shall include all necessary precautions and provisions for the safety of operating and maintenance personnel.

A3.3.2. Special care shall be taken to make enclosed equipment proof against entry of rat, lizards and other creeping reptiles, which may create electrical short circuits inside, live equipment.

A.3.3.3. Continuity of power supply is the first consideration and the design shall be such as to provide facilities to simplify inspection, testing maintenance, clearing and repair at site.

A.3.4. **SPECIAL SITE CONDITIONS:-**

A.3.4.4. The equipment with their accessories shall be designed for smooth, efficient and trouble free operation in tropical humid climate for maximum temperature of 50 degree C and maximum humidity of 98 percent. Maximum temperature and maximum humidity are however not likely to occur simultaneously. De-rating of equipment shall be done for an ambient temperature of 50 degree C.

A.3.5. **PAINTING:-**

All items of equipment and materials shall be thoroughly cleaned and painted in accordance with IS Specification. The clean surface shall be given two coats of epoxy polyamide resin based red-oxide zinc-phosphate primer, deposited either by immersion or powder spray. They phosphate coated surface shall have one coat of high build epoxy resin based intermediate paint coating and two coats of air drying epoxy polyamide enamel suitably pigmented finish paint. The colour shade for exterior parts of equipment located inside the sub-station control room building shall be as per shade No. 631. Clean and touch-up paint shall be applied at site as required.

PART-B

TECHNICAL SPECIFICATION FOR 50V- 50,75,100 &125 Amp

SMPS BASED AUTOMATIC FLOAT-CUM-BOOST CHARGERS SUITABLE FOR 48V MF-VRLA BATTERIES.

1. SCOPE:

This specification covers the design, manufacture testing before dispatch, delivery at site and erection, testing & commissioning at site of 50V Automatic Float-cum- Boost Charger of different capacities and comprehensive AMC thereof for 5(Five) years beyond successful completion of guarantee period..

2. BASIC REQUIREMENT:

2.1. The charger shall preferably be modular type based on high frequency switching mode power supply(SMPS) technique using IGBT devices and the front mounted SMPS modules should be hot swappable.

2.2. The float -cum- boost charger shall be suitable for charging 48V battery in addition to trickle charging and feeding power to communication equipment whenever AC mains supply is available to the charger.

2.3. In spite of the fluctuations in the voltage and the frequency variation of mains supply to the charger, there must be line regulated DC output voltage for feeding the communication equipment load. The DC output voltage shall also be load regulated.

2.4. In the event of mains supply failure, the batteries shall supply total load current as long as the battery is not discharged below 40V . A Low Voltage Disconnector (LVD) should protect the battery from deep discharge. On restoration of main supply the float-cum-boost charger shall resume its normal function of charging the battery as well as feeding communication equipment load automatically.

2.5. Depending on the status of battery i.e voltage per cell and previous discharge history, there shall be need for automatic switching between float and boost charging. Separate outputs for battery and equipment should be available, otherwise dropping diode technique may be used to prevent boost voltage appearing across the load.

2.6. Digital Control: charger should employ digital control with DSP controller for providing predictive control of rectification & monitoring capability. The charger should have a multi line dot matrix display of suitable size , on front panel to indicate control status and event log.

2.7. The side and top panels of the equipments should be designed in such a way to allow sufficient ventilation for the components. The ON – OFF switch, input and output fuses, indication lamps, voltmeters, ammeters, filters, condensers fuses, output voltage

control are to be provided on the front panel. Cable entry holes shall be provided at the bottom with suitable clamping arrangements.

COMPONENTS:

2.8. Components used shall be of professional grade of reputed manufacturer. Iron and ferrite core transformer and chokes if used shall be wound with copper with adequate insulation provided.

2.9. **The positive output of SMPS units must be connected to common ground**. Circuit breakers, output fuse, ammeter shunt etc should be provided on the negative path of the output. Sensing circuit , fuses or circuit breakers shall be provided wherever appropriate to protect the charger

2.10. Suitable mechanical front loading rack arrangement for holding modules in position shall be provided so that the modules are held firmly by sliding through it.

2.11 **Efficient earthing of the Charger shall be provided, taking care that in communication system 48V DC positive is always connected to earth.**

PROTECTION:

2.12. Protection circuit should be provided for the following cases:

i) Under voltage / Over voltage for both input and output.

ii) Over load / short circuit.

iii) Battery earth Fault

iv) SMPS Unit failure.

v) Wrong battery connection/reverse polarity

vi) Power ON self test

vii) Supply wrong phase, phase failure.

VISUAL INDICATION:

2.13. Visual indication such as LED, Dot matrix LCD etc. shall be provided to indicate:

(a) Mains available

(b) Phase failure / wrong phase

(c) Charge/ Discharge

(d) Charger over load

(e) Float mode/ Boost mode

(f) Output fail

(g) Battery Low.

ALARM FACILITIES:

2.14. The equipment shall be provided with audio alarm facility for all the conditions as mentioned in 2.12 with suitable resetting facilities. The audio alarm in respect of the above conditions should automatically reset itself after a lapse of 30 seconds. The visual indication should persist till the fault is cleared. Potential free contact shall be provided for extension of alarm for centralised display.

COMPONENT MARKING:

2.15. Each electrical component should be located on the PCB by the layout / circuit diagram. The wiring shall be clearly and permanently identified with a designation or a colour code which must correspond to the equipment circuit diagram.

2.16.
CABINET

Free standing steel cabinet 1.6/2.0
Or above gauge sheet steel. Degree of protection not less than IP42

NAME PLATE:

2.17. A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on the cabinet of the charger and should contain following information.

a) Specification No.
b) Type of the unit
c) Manufacturers name
d) Model No.
e) Serial No.
f) Input voltage and phase
g) Output voltage and current
h) Year of manufacture

HEAT – RUN:

2.18. All units shall be subjected to heat run test of 12hours at full load and temperature of component shall not be more than as mentioned below:

a) Transformers and chokes - 70°C
b) Transistors / diodes /FETs - 60°C or as per component spec.

INSULATION RESISTANCE:

2.19. The insulation resistance of the charger when tested with a 500V DC megger shall be as given below.

a) AC input and earth - Greater than 2 Meg. Ohms.
b) DC output and earth - Greater than 1 Meg Ohms.

c) AC input and DC output - Greater than 5 Meg ohm

LIGHTNING PROTECTION:

2.20. The system shall be adequately protected against lightning at the input.

RADIO FREQUENCY INTERFERENCE SUPPRESSION:

2.21. The equipment should be designed to minimize the level of electromagnetic interference both conductor and radiator, detected in the vicinity of the equipment and generated by switch mode power conversion equipment inside the charger.

TOTAL VOLTAGE HARMONIC DISTORTION:

2.22. The total line harmonic voltage distortion shall not be more than 10%.

TOTAL CURRENT HARMONIC DISTORTION:

2.23. The total current harmonic distortion contributed by the unit shall not exceed 20% for all input condition and load 50% to 100% of the rated capacity.

MANDATORY SET OF SPARES:

2.24 The suppliers shall provide the following mandatory spares for each of Charger supplied.

(a)	AC Contactor (if used in the charger)	:-	1 no./ charger
(b)	DC Contactor (if used in the charger)	:-	1 no./ charger.
(c)	Required HRC Fuses of appropriate rating	:-	4 nos./ charger

INSTRUCTION AND MAINTENANCE MANUAL:

2.25 Two copies of the instruction manual shall be supplied along with each unit. The manual has to include dimensioned layout drawings, detailed circuit and schematic diagrams, PCB layout and detailed inter connecting drawings of modules and switching arrangements. Details on testing and adjustment procedure, initial check on receipt at site, detailed installation and commissioning procedure, maintenance procedure, proposed routine maintenance tests, actual test results obtained for the particular unit at the factory.

2.26 detailed trouble shooting chart shall be outlined in the manual.

Instruction manual is to be prepared using good quality paper. All drawings in Clear printing shall be attached to the manual along with the flow chart drawing necessary for trouble shooting.

2.27. The bidder shall arrange for training of at least five Telecom. Engineering personnel of OPTCL on operation & maintenance of 50 V Float-Cum-Boost chargers free of cost. Every details regarding repair of all probable defects need be imparted to the trainee engineers at works of the manufacturer. The bidder in their offer need intimate the duration of training. However the training must be conducted prior to delivery of the Battery chargers.

TYPE TEST

2.28 The bidder shall submit the test reports along with his offer for the following type tests conducted on the offered samples as per relevant National Standard (s) within five years from the date of opening of the bid and test-witnessed by any Government Department /Government undertaking, failing which the offer is liable for rejection.

(a) Measurement of Power loss/ consumption in rectifier auxiliaries

(b) Equipment reactance test

(c) Measurement of voltage regulation / AVR regulation

(d) Efficiency and power factor measurement test

(e) Temperature rise test so as to determine the temperature rise of Semiconductor, Ferrite cores and cabinet etc.

(f) Measurement of insulation resistance.

(i) AC input to earth.

(ii) AC input to DC output.

(iii) DC output to earth

(g) DC voltage current characteristic

(h) High Voltage Tests.

(I) Determination of regulation

(J) Measurement of ripple

(k) Reverse leakage test

(l). Test for confirmation of reduction in float voltage with increase of battery temperature and vice-versa.

The bid offers in confirmation to the above tests as well as the tests certified by **Telecom RDSO center and followed by REL-TEL** shall be given due weight age.

ACCEPTANCE TESTS:

2.29 Followings shall constitute the acceptance tests which shall be tested by the purchaser's representative at the works of the manufacturer at the cost of the supplier for each charger. No sampling is allowed.

(a) Measurement of voltage regulation

(b) Efficiency and power factor measurement

(c) Temperature rise test so as to determine the temperature rise of Semiconductor capacitor, choke, Ferrite cores and cabinet etc.

(d) Measurement of insulation resistance.

(I) AC input to earth

(ii) AC input to DC output

(iii) DC output to earth

(e) DC voltage current characteristic

(f) High voltage tests.

(g) Determination of regulation.

(h) Measurement of ripple

(I) Tests for indications and alarms as per this specification

(j) Tests for indicating instruments.

(k) Determination of system set points.

(l) Soft start test

N.B. : The supplier shall provide arrangements for monitoring the temperature across the elements, as stipulated above, continuously during the temperature rise test without disconnection of any of the temperature measuring devices across the hottest spot of each of the above elements.

All other tests, as may be necessary to ensure that all equipment's are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates, vendor's test certificates for different equipment's, accessories, instruments etc. shall be submitted, whenever required by the purchaser.

. **DRAWINGS / DOCUMENTS**

2.30 The bidders shall submit the following drawings / documents along with their offer failing which the offer is liable for rejection.

(a) OGA of the battery chargers
(b) General layout with overall dimensions
(c) Electrical schematic diagram showing connections and controls.
(d) Leaflets and technical literature giving detailed information of the panels offered.

The bidder shall submit the following drawings / documents in 3 (three) copies within 15 (fifteen) days from the date of issue of the purchase order for purchaser's approval.

(a) OGA of the battery chargers

(b) General layout with overall dimensions marked along with sectional views showing cable entry position etc.

(c) Rating calculations for power semiconductors, torridly transformers, capacitors inductors etc.

(d) Detailed schematic and connection and control wiring diagram for all the equipments.

(e) Complete bill of materials

(f) Technical excerpts on operation.

GUARANTED TECHNICAL PARTICULARS

2.31 The guaranteed technical particulars of this specification shall be furnished along with the tender. Any tender, lacking complete information in this respect is likely to be rejected.

DEVIATION FROM SPECIFICATION

2.32 All deviations from the specification shall be separately listed in the technical deviation sheet(As per Annexure-XIIB), in the absence of which it will be presumed that the provisions of these specifications are complied with by the tenderer. Any extra feature/equipment/ instrument as necessary for operation and performance of the

battery charger for the 48V MF-VRLA batter set as per this specification shall be provided without any extra cost to OPTCL. **The extent of up gradation facility shall be mentioned**.

TRANSPORT :

2.33 The chargers along with its accessories shall be suitably packed and transported to site in ready to use condition.

3. BRIEF TECHNICAL SPECIFICATION:

The required capacity of chargers may be 50V-150A/125A/100A/75A/50A/50A Chargers of 75 Amp. Rating and above shall be of 3 phase type.

Charging Curve: Completely programmable .Can support batteries of any type, voltage, capacity.

a) Input Voltage: - 230 ± 20% VAC single phase in case of 25A, 40A and 50A charger. 30%
400 ± 20% VAC three phase in case of 60A, 75A, 125A and 160A charger 30%

Frequency – 50Hz ± 5%

Power factor – Single phase model- > 0.90 at full load

Three phase models >0.97 at full load .

Voltage withstand test – 1500V AC input to chassis for 1 minute.

b) Float mode – Adjustable 48V – 52 V Trickle charging of battery and simultaneously supplying the load.

Boost mode – Adjustable 48V – 65V

Boost charging of battery and simultaneously supplying the load after suitable voltage dropping arrangement.

Static Regulation – Line : ± 0.5%

Load : ± 0.5%

Dynamic Regulation : ± 0.5% for 10% - 90% - 10% stop load change.

± 1 % within 1 m sec. Of stop change.

± 1 % for ± 25% stop change in AC input voltage.

Phosphometric noise (emf weighted at 800 Hz)

< 2mV rms while delivering full rated load at normal input.

Out Ripple:- Less than 1% RMS at full load.

EFFICIENCY:

a) Single Phase AC

i) At normal input, output and full rated load : - Better than 85%.

ii) For other specified input output condition and load between 25% to 100% : - Better than 80%.

b) Three Phase AC

i) At normal input, output and full rated load : - Better than 90%

ii) For other specified input, output conditions

and load between 25% to 100% : - Better than 85%.

ANNEXURE – II

GUARANTEED TECHNICAL PARTICULARS FOR
BATTERY CHARGER (48V D.C. SYSTEM) SUITABLE
FOR SPECIFIED MF-VRLA TYPE STORAGE BATTERY

(To be filled in by the Bidder)

Values/ Others

1. MANUFACTURER'S NAME
2. RATED OUTPUT OF THE CHARGER
2.1 Voltage (volts)
2.2 Current (amps)
2.3 Power factor
3. SHORT TIME RATING
4. TYPE OF COOLING
5. HOTTEST STACK TEMPERATURE (^{0}C)
6. CHARGER DIMENSIONS
   (a) Height (mm) :
   (b) Depth (mm) :
   (c) Width (mm) :
   (d) Sheet thickness (mm) :
7. CHARGER WEIGHT :
8. CHARGER RATED OUTPUT CURRENT
   (a) Float charging mode :
   (b) Boost charging mode :
9. LOAD LIMITER CURRENT SETTING RANGE (Trickle mode)
10. AUTOMATIC VOLTAGE REGULATOR MODULE
10.1 manufacturer's name
10.2 Manufacturer's type
10.3 Percentage stabilization of the rectifier with the help of AVR when

(a) Input voltage changes with ± of its nominal value.

(b) DC output of the rectifier varies from no-load to full load.

11.4 Rated output voltage

11.5 Allowable AC frequency fluctuations

10.6 Voltage setting range

10.7 Response time of automatic voltage regulator

11.0 CONTACTORS / MOULDED CASE CIRCUIT BREAKERS

11.1 Type

11.2 Make

11.3 Rated voltage (V)

11.4 Rated continuous currents (A)

11.5 Contact material

11.6 Operating coil

11.7.1 Voltage (V)

11.7.2 Voltage range and power for closing and holding

11.7.3 Voltage range and power for drop off.

11.8 Details of CT if any

11.9 Auxiliary contacts.

11.9.1 Number

11.9.2 Current rating

11.10 Characteristics of back-up HRC fuse.

12.0 **RELAYS :**

12.1 Make and type of protective and alarm relays

(a) Thermal overload relay

(b) Input under voltage relay

(a) Single phasing alarm relay

(b) Phase reversal relay

(c) D.C. output over-voltage relay

(d) D.C. output under voltage relay

(e) Charger failure relay

(f) Battery earth fault relay

(g) A.C. input failure relay (for connecting the D.C. load)

(h) Fuse failure relay

(i) Alarm accept relay

12.2 Rated voltage of each of the above

(a) AC/DC

(b) Permissible variation

(c) Frequency

12.3 VA burden of each of the above

12.4 Operating time of each of the above

12.5 Reset time

12.6 Accuracy

12.7 Setting range

12.8 Reset factor

12.9 Number of contacts

a. Normally open

b. Normally closed

12.10 Rating of contacts

(a) Rated Voltage (V)

(b) Rated making and breaking

(c) Continuous rating

12.11 Operation indicator

13. **INDICATING LAMPS/ LCD DISPLAY**

13.1 Manufacturer's name

13.2 Type and designation

13.3 Permissible voltage variation

13.4 Rated power consumption (watts).

13.5 Series resistance, if any

14. SWITCHES:

14.1 Manufacturer's name

14.2 Ratings

(a) Continuous current

(b) Short circuit – making capacity

(c) Breaking capacity

(d) Voltage

14.3 Operating mechanism details

14.4 Type of visual indication

(a) OFF and ON position

(b) Fuse blow out

15.0 FUSES/Circuit breaker

(a) Make
(b) Type
(c) Rating (Amps)
(d) Interrupting rating (KA)

16. **INSTRUMENTS**

16.1 Manufacturer's Name

(a) Ammeter
(b) Voltmeter

16.2 Type

(a) Ammeter
(b) Voltmeter

16.3 **Standard**

(a) Ammeter
(b) Voltmeter

16.4 Scale range

16.4.1 Ammeter

(a) Float charger
(b) Boost charger
(c) Battery float
(d) Battery boost

16.4.2 Volt meter

(a) Input supply
(b) Charger output
(c) Load

16.5 Size of dial

(a) Volt meter
(b) Ammeter

16.6 Accuracy class

(a) Volt meter
(b) Ammeter

16.7 Temperature at which calibrated

16.8 Limit of errors

16.9 Out line dimensions

16.10 Type of mounting

16.11 Selector switch for volt meter (AC & DC)

(j) Make
(k) Rating

17. Reference float voltage at ambient temperature of 27^0C

18. Whether protection is given for float voltage to Avoid low battery voltage due to sensor or circuit Malfunction. (Yes/ No)

19. Whether the positive output of SMPS units is connected to common ground. Circuit breakers, output fuse, ammeter shunt etc are provided on the negative path of the output (Yes/No)

ANNEXURE – IV-A

(For Testing of Battery)

(To be filled in by the bidder)

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibr-ation	Due date of Calibration	Name of the Calibratig Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes, state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equip-ment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for correspondin g test(s)	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Signature of the tenderer with seal & date

ANNEXURE – IV-B

(For Testing of Battery Charger)

(To be filled in by the bidder)

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS

Name of the Test	Meters & Equipments required for the corresponding test with range, accuracy, make & Sl. No.	Date of Calibr-ation	Due date of Calibration	Name of the Calibrating Agency	Whether Calibrating Agency is Govt. approved	Whether documents relating to Govt. approval of the calibrating Agency furnished	Whether the meters/ equipments fulfil the accuracy class as per calibration report.	Whether the calibrating agency has put any limitation towards the use of the particular meter/ equipment. If yes state the limitations	Whether the calibrating agency has put any limitation towards the use of the particular meter/equip-ment/ meter. State the colour of the affixed sticker	Inspite of imposed limitations. Whether the particular meter / equipment can still be used ? Justify its use for corresponding test(s)	Remark
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Signature of the tenderer with seal & date

ANNEXURE V – A

(To be filled in by the bidder)

CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape along with drawings etc. furnished or not ?	Whether the type tested Plante lead acid battery fulfills the technical requirements as per TS	If the type tested battery does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Signature of the tenderer with seal & date

ANNEXURE V – B

(To be filled in by the bidder)

CHECK LIST TOWARDS TYPE TEST REPORTS FOR BATTERY CHARGER

Name of the Type Test	Date of Test	Name of the Laboratory where the Test has been conducted	Whether the Laboratory is Government approved	Whether the Test report is valid as per Spn.	Whether the Test report in complete shape along with drawings etc. furnished or not ?	Whether the type tested battery charger fulfills the technical requirements as per TS	If the type tested battery charger does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct he particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Signature of the tenderer with seal

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

DISTRUBUTION BOARDS

1) **ACDB**
2) **DCDB**
3) **OTHER CONSOLES INCLUDING BMK**

1) TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARDS

General

Requirements of AC and DC systems

The electrical auxiliary systems shall be of a quality commensurate with the performance, reliability and availability requirements of the substation.

The electrical station services shall be in accordance with all the relevant standards, shall satisfy the requirements specified herein and shall be designed to operate in the environmental conditions specified in the relevant sections of this Specification.

The electrical station systems shall be required to provide the voltage classes indicated in Table 1.1. for operation of various plant equipment operating mechanisms, plants, control and communication systems

Nominal Voltage V	Tolerance	Frequency Hz or DC	Phases	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
220	187V to 242V	DC	DC	2	Isolated 2 wires
50	±10%	DC	DC	2	+ve earthed

Table 1.1. Voltage classes

The auxiliaries shall be capable of withstanding all over frequency and undervoltage conditions without loss of supply to the power circuits or shutdown of any auxiliary system meeting the essential loads of the substation plant and equipment.

Configuration

The basic design of the substation electrical auxiliary services shall be as shown in the schematic drawing. This drawing is for guidance only and the Contractor may propose an alternative keeping in view the design philosophy stipulated in this section of the Specification. The design philosophy for auxiliary supply systems shall be as follows:

a) The AC supply for station auxiliary systems shall generally be obtained from a single source from the local distribution network having a track record of good power availability. For 400/220kV substations two separate sources shall be used.

b) Where 11kV or 33kV busbars are available at the substation site station auxiliary transformers shall be installed to provide reliable auxiliary power supplies. At least two auxiliary transformers of a rating sufficient to feed the substation load shall be installed. Where specified, in order to meet the station essential loads a back-up supply from a standby diesel generator set shall be provided. The requirement of diesel generator sets have been indicated in the bill of quantity of relevant schedules.

c) The Contractor shall estimate loads of the substation and determine the required capacity of station auxiliary transformers and diesel generator set and submit same for the approval of the Project Manager. The contractor shall classify the loads based on the principles defined in the following clauses.

Load Classes

Essential loads

These are loads whose failure will affect the capability of the station and station plant and equipment. These loads shall include cooling and other auxiliaries of transformers and reactors, non-interruptible power units, auxiliaries of reactive power compensator, and station services of the relays in the substation.

Emergency loads

These are loads that must remain in service during complete loss of the ac power supply. These loads shall include the station battery chargers, disconnecting switch and circuit breaker operating mechanisms, control room air-conditioning and the emergency lighting of the switchyard and control building. Some emergency loads operate on ac voltage and the others on dc voltage.

Normal loads

These loads, whose failure does not affect capability, shall include but not be limited to control building and switchyard lighting, control building air-conditioning except in control room, air compressors, normal and fire-fighting water pumps, oil treatment loads, etc.

Basic design criteria

The failure or the disconnection for maintenance of any motor, feeder, motor control centre, or 415V power centre or auxiliary transformer shall not affect the power transmission capability of the substation.

To achieve the above criteria, the following facilities shall be incorporated, by the Contractor, in the design of the auxiliary systems :

1. Highly reliable duplicate primary supply sources, with automatic change-over facilities.

2. Duplicate essential loads (e.g. cooling pumps, fans, heat exchangers, etc.). Duplicated loads shall be supplied from two different 430VAC distribution boards (ACDB). Essential loads which are not duplicated shall have duplicated supply circuits with the source having auto change over facility.

3. Provision of a diesel generator set for the essential loads. The generator shall start up automatically, in case of loss of all normal and stand by supplies, to feed the essential loads and emergency loads.

4. In order to limit fault currents, to prevent back feed into the AC bus, and to ensure independence of supply sources, parallel operation between station service transformers shall not be permitted at any voltage level. Also parallel operation shall not be permitted between transformers and diesel generator.

5. System shall be clear and simple to operate to minimise the risk of loss of supply due to human error.

6. The Contractor shall design the LV distribution system to ensure that the voltage supply limits are maintained at all times and that the switchboards and cabling are never overloaded. On larger stations it may be necessary to supply more than one main LVAC switchboard.

415V AC distribution system

General

The 430V secondary distribution system shall comprise 430V power centres serving the different classes of loads either directly or through motor control centres.

Each power centre shall consist of two sections, supplied through two station service transformers of adequate capacity. Each transformer and each section of the 430V power centre shall be designed to carry the total load of both sections. The two sections shall be interconnected through normally open bus tie breakers and normally closed fuse disconnects.

An automatic transfer scheme shall be incorporated within each power centre. This transfer scheme shall automatically disconnect the voltage deficient bus and then re-energise it from the healthy bus.

Restoration of normal supply conditions shall automatically return the power centre to the normal operating mode. The 430V power centres shall be of the metal enclosed switchgear type according to the relevant IEC or Indian Standards.

AC distribution board.

The ACDB's shall be in accordance with the relevant IEC or Indian Standards and shall also comply with the following requirements:

- The MCC shall be located near the supplied loads or inside the control room at a suitable place.
- The circuit breakers of the MCC shall be individually interlocked to prevent paralleling of two different power centre buses.
- The 240V loads shall be supplied by 240V panels located in the MCC or outside the MCC where it is required.

Supply of essential loads

Essential loads shall be fed from ACDB-1 and ACDB-2 respectively. A diesel generator set shall be connected as indicated in schematic drawing so as to meet the complete requirement of the essential loads of the substations. ACDB's shall be independently fed from two different sections of the main distribution board.

Supply of emergency loads

The emergency loads shall also be supplied from essential bus ACDB-1, ACDB-2, 220V DCDB-1 and 220V DCDB-2, and 50V DCDB-1 and DCDB-2 as shown in the schematic drawing.. These loads shall be supplied from the two different buses under duplicate supply philosophy. Switchyard bay kiosks shall be fed from the two different buses alternatively and interconnected locally with auto changeover switches. Power supply to equipment operating Mechanisms shall be fed from the respective bay kiosks.

Supply of normal loads

Normal loads shall be fed through motor control centres connected with two cables to two different sections of the 415V power distribution centres. A manual change-over switch shall be installed in each MCC, so that the supply is not lost in case of maintenance of one section of the 415V power centre or for a fault. These MCC shall also supply the lighting and small single-phase loads through 240V lighting or distribution panels, located in the MCC and all over the substation.

Some loads, such as switchyard lighting and air-conditioning of the control buildings, normal and fire-fighting water pumps, shall be supplied by duplicate feeders so as not to interrupt working in case of maintenance of one of the sections of the power centre.

For oil treatment and welding, special service outlets shall be provided in local 415V motor control or distribution centres.

2.0 LVAC supplies and equipment

General

Switchboards shall be of the free standing design, suitable for mounting directly above the cable trenches laid inside the control room. Cable trench walls shall be flush with the control room floor. Switchboards shall be suitable for terminating all incoming and outgoing cables and will normally be of the bottom rear entry type, generally in accordance with IEC 947 and 439 and of metal clad design arranged for drawout isolation. Switchboards shall be equipped with circuit breakers and moulded case or miniature circuit breakers. The use of fuse switches will not be permitted.

LVAC scheme

General requirement

The 415V incoming supplies shall be derived from the station auxiliary transformers or in the case of a loss of supplies, from the standby diesel generator where ever applicable. The two incoming supplies shall be interlocked to ensure that only one of the two circuit breakers can be

closed at any one time. Where a bus section circuit breaker is provided it shall also be suitably interlocked to prevent the station auxiliary transformer from being backfed.

Main distribution board

The two sections of the main distribution board shall be supplied from separate station auxiliary transformers. The two sections shall have automatic change over facilities in the event of failure of supply from one source. Each section of the board shall feed the following panels:

- Main lighting distribution board
- Fire fighting pump house.
- AC and ventilation plant
- Maintenance equipment and oil treatment plant supplies.

AC distribution board

This shall comprise two sections each of which shall be supplied through different cables from both sections of the main distribution board. Each sections shall be equipped with a back up feed from the standby diesel generator set with automatic change-over facility to generator in the event of loss of supply from the main distribution board.
The AC distribution board shall supply the following loads:

- Control room supply for panels, computers, etc..
- One section of the 220V battery charger / rectifier.
- One section of the 50V battery charger / rectifier .
- 50% of switchyard bay marshalling kiosks.
- Emergency AC lighting system.
- Transformers and reactors (cooling devices and OLTC panels)
- Fire water and civic water pumps
- Spare feeders for future use.

Main lighting distribution board

The main lighting distribution board shall receive incoming supplies from the two sections of the main distribution board as well as a supply from the diesel generator set. This board shall be further connected to lighting panels through a lighting sub-distribution panel. The panel supplying emergency lighting load and the income from the diesel generator shall be equipped to switch on in the event of failure of supply from the primary source.

3.0 Construction

Panels

For indoor applications the switchboards shall be of the cubicle pattern, each circuit being self contained within its own cubicle (compartmentalised type). An access door shall be provided for each cubicle such that access can only be obtained to individual circuits. Circuits shall be segregated one from the other by earthed metal. For outdoor installation they shall be of multi-box construction.
Sheet steel for fabrication of the panels shall be a minimum of 2 mm thick cold rolled grain oriented sheet steel or 2.5 mm hot rolled sheet steel.
All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Switchboard

Switchboards shall be vermin proof and suitable for use in a tropical climate. All ventilating louvers shall be covered with a fine mesh from inside.

All switchboards shall be provided with a degree of protection of IP 52 as per IEC 947 or equivalent Indian standard. Provision shall be made in all compartments for providing IP 52 degree of protection, when circuit breaker or module trolley, has been removed.

Switchboards shall be of uniform height and shall not exceeding 2450 mm.

Switchboards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers.

All switchboards shall be divided into distinct vertical sections, each comprising:

1. A completely enclosed busbar compartment for horizontal and vertical busbars. Busbar chamber shall be completely enclosed with metallic partitions. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance. Access shall be possible without disturbing feeder compartment.

2. Completely enclosed switchgear compartment(s), one for each circuit for housing circuit breaker or motor starter.

3. A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with busbar chamber.

4. A compartment for relays and other control devices associated with a circuit breaker.

All access doors shall be provided with facilities for locking in the closed position. It shall be possible to move each circuit breaker or MCCB to the disconnected position without the need to open the cubicle access door. Attempted disconnection of a circuit breaker or MCCB when in the closed position shall not result in tripping of the particular equipment.

4.0 Cubicle

Cubicles may be arranged vertically in tiers, the number being limited only by the need to ensure that circuits are thermally independent.

It shall be possible to work within each cubicle with the equipment withdrawn whilst the incoming contacts are energised. The minimum requirements for protection shall be:

- Insulating barriers installed between phases within the cubicle.

- An insulating cover to be affixed over the protruding feeder and busbar connections when the equipment is withdrawn.

Where this is not available, protection shall be provided by automatically operated shutters. It shall be possible to open the shutters intentionally, against spring pressure for testing purpose.

Each phase of the down dropper connections from the busbars to the equipment isolating contacts shall be separated from the incoming or outgoing connections and from the other phases by barriers.

Cubicles shall be suitable for terminating all necessary cabling whether of copper or aluminium conductor design. It shall be possible to terminate any cable whilst adjacent circuits are energised.

5.0 Busbar and other equipment housing

All incoming connections, busbars and feeder connections up to the particular MCCB shall be capable of the short time current rating specified, but connections beyond the MCCB need only be matched to the MCCB characteristic.

The overall height of each tier of cubicles shall be such that the operating handles of all equipment are within the reach of a person standing at ground level. Control switches as specified shall be fitted and suitably labelled to indicate their function.

The equipment shall be complete with cable boxes and glands suitable for XLPE or PVC insulated cables.

The switchboard shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.
Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.
All equipment associated with a single circuit shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides with the with-drawable units in position or removed. The front of the compartment shall be provided with a hinged single leaf door complete with locking facilities. The main switch shall be operable from outside and will be interlocked with the compartment door such that the latter can be opened only when the switch is off. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. The main switch shall have the facility of being pad-locked in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch.
After isolation of power and control circuit connections it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable termination located in cable alley.
The temperature rise of horizontal and vertical busbars when carrying rated current along its full run shall in no case exceed 55C, with silver plated joints and 40C with all other type of joints over an outside ambient temperature of 50C.
All single front switchboards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.
All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carry out modifications.
All 415V switchgear cubicles shall be of single front type, with fully withdrawable circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between **SERVICE, TEST** and **ISOLATED** positions and for withdrawal from the switchboard. Testing of the breaker shall be possible in the **TEST** position.
Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to prevent accidental contact with the live parts of one circuit when working on the other circuit.
All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.
All modules shall be fixed type except circuit breaker and motor feeder modules, which shall be drawout type.
The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.
All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to approval of the Project Manager.
All sheet metalwork shall be painted in accordance with the painting clause specified elsewhere in this Specification. The shade of the paint shall be 692 as per IS 5 (smoke grey).

Earthing

It shall be possible to earth all incoming supplies to the switchboard by means of a fully rated earthing device, either by using the circuit breaker with earthing attachments, a separate earthing truck, or a fixed fully rated earth switch.
Busbars and dead end feeders may be earthed by means of a voltage checking device and hand applied portable earth switches. These shall normally be applied from the front of the switchboard.

Earthing of current free metallic parts on the body of the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm^2 and the main earth bar for the switchboard shall be brought out to two terminals for connection to the station earth grid.
Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

Clearances and insulation level
Clearances and creepage distances in air shall be those stated in IEC 158 and 947 and be such that the equipment can withstand the dielectric tests specified.

Thermal performance of switchboard and equipment
The complete switchboard shall be capable of carrying rated load current without the temperature rise of any portion exceeding a level of 65C. Parts that may be touched by operating personnel shall not exceed a level of 35C. In determining the load current performance of tiered cubicles it shall be assumed that all circuits are carrying rated current. The cross sectional area of the busbars may be graded according to the current rating, but shall remain capable of the short time current rating stated in the Schedules.

Protection co-ordination
It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and down stream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.

6.0 EQUIPMENT TO BE FURNISHED

General
The Contractor shall supply all equipment in accordance with this Specification in each of the modules as specified in the following sub clauses.

Type Designation /Description of Modules
Each 415V switchgear and distribution board shall comprise of a number of different type of modules as detailed in the following clauses. The Contractor shall obtain the approval of the Project Manager for the details of the modules to be provided in each of the Boards. The Employer has classified and type designated the modules to be used in the various Boards.

Module type	Application
AE	Electrically controlled circuit breaker for incomer and bus coupler
M1	Circuit breaker controlled motor feeder
M2	MCCB controlled motor feeder
E	
G1	VT module with undervoltage relay
G2	
H and H(BC)	Isolating switch controlled incoming circuit
S	DC metering and protection module
X	
DC	Incomer from battery and charger
DG1	Electrically controlled circuit breaker for incomer from DG set
H1	
EL	
K2	Non reversible motors having star stop control at MCC
AN	Annunciator module

Table 4.2. 430V switchgear modules and applications

Composition of the Modules
The following are the preferred composition of various modules along with their Bill of Materials. However the Contractor may suggest alternatives keeping in view the requirement of

the specification. Such changes shall be subject to approval of the Project Manager. In addition to the items listed all other items required to provide the necessary functionality as specified in this Specification, shall be deemed to be included in the scope of supply for the module.

7.0 (A) Module type AE

1.	Triple pole air circuit breaker (Device No. 52) complete with all accessories and power operated mechanism as specified.	1
2.	Neutral link.	2
3.	Circuit breaker control switch with spring return to normal.	1
4.	Current transformer for metering.	3
5.	Ammeter	1
6.	Ammeter selector switch.	3
7.	Current transformer for relaying.	3
8.	Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time. Alternatively suitable overcurrent releases capable of proper discrimination with all down-stream protection are also acceptable.	1
9.	HRC control fuse.	8
10.	Auxiliary relays	4
11.	Indicating lamps with series resistors and selector lenses (e.g. red, blue, green, white and amber	5
12.	Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 88% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.	1

7.0 (B) Module type M1

1.	Triple pole air circuit breaker complete with accessories, and power operated mechanism as specified.	1
2.	Circuit breaker control switch with spring return to normal.	1
3.	Three position 6 pole selector switch SWITCHGEAR / NORMAL / TRIAL.	1
4.	Current transformer for metering.	3
5.	Ammeter	1
6.	Ammeter selector switch.	1
7.	Current transformer for relaying.	3
8.	Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as require	1
9.	Double pole inverse definite minimum time overcurrent relays connected in R and B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT secondary current and time setting range of 0-30 seconds. The relay shall be CDGM-22 (GEC Alsthom) or equivalent.	1
10.	Single pole adjustable definite time delay relay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously	1

adjustable time delay range of 2.5 to 25 seconds.

11.	Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.	1
12.	Auxiliary relays	4
13.	Indicating lamps with resistors and coloured lenses suitable for 220V DC. -	5
14.	HRC control fuses.	8

7.0 (C) Module type M2

1.	415V, 250A, P2 duty 20 kA, 50 Hz MCCB having 4 NO and 4 NC Aux. contacts.	1
2.	Auxiliary relays	1
3.	Indicating lamps with resistors and coloured lenses suitable for 240V AC.	3

7.1 Module type E

1.	Triple pole load break isolating switch	1
2.	Neutral link	1
3.	HRC fuses	3

7.2 Module type G1

1.	(415/√3)/ (110/√3) volts single phase voltage transformer star/star connected with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA burden.	3
2.	HRC Fuses mounted on the above chassis.	6
3.	Four position voltmeter selector switch.	1
4.	Voltmeter (0-500V)	1
5.	Double pole instantaneous undervoltage relays with continuous variable setting range of 40-80% of 110 Volts.	1
6.	Time delay pick up relay having a time setting range of 0.5 to 3 seconds. With 3 NO self reset contacts, suitable for 220V DC.	1
7.	Auxiliary relay 220V DC with 2 NO. self reset contacts.	1
8.	Indicating lamps with series resistor and colour lenses (Red, blue and yellow).	3

7.3 Module type G2

1.	HRC Fuse	3
2.	Voltmeter (0-500V)	1
3.	Voltmeter selector switch four position (R-Y, Y-B, B-R OFF).	1
4.	Indication lamps (Red, blue and yellow)	3

7.4 Module type H and H (BC)

1.	Triple pole load break isolating switch with padlocking facility in OFF position and arrangement to defeat door interlocking	1
2.	Neutral link.	1
3.	Red indicating lamp to indicate isolating switch closed position.	1

7.5 Module type S

1.	Voltmeter 0-300V DC for 220V DC DB	1

2.	Voltmeter 0-75V DC for 50V DCDB.	1
3.	Three (3) position voltmeter selector switch	1
4.	Instantaneous under voltage relay with 95% of 220V DC. The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage.	1
5.	Instantaneous over voltage relay with setting range of 110% of 220V DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series capable of resetting the relay at about 95% of the operating voltage.	1
6.	Earth leakage relay only for 220V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/240V AC Auxiliary supply.	1
7.	Indicating lamp each for fault annunciation and for 220V DC with earth leakage relay mentioned above.	2
8.	HRC control fuses.	2

7.6 Module type X

1.	Double pole single throw 250V DC air break isolating switch.	1
2.	HRC fuses	2

7.7 Module type DC (Incomer from battery and chargers)

1.	HRC fuses for incomer from battery.	2
2.	DC ammeter with shunt and range of 40-0-50 Amps. For 220V DC DB and 60-0-150 Amp for 50V DC DB.	1
3.	Double pole single throw 250V DC air break switch.	2
4.	HRC fuses for incomer from charger.	2
5.	Double pole single throw 250V DC air break switch connecting battery and charger sections to DCDB	1

7.8 Module type DG1

1.	Triple pole circuit breaker complete with all accessories and power operated mechanism as per the relevant sections of this Specification.	1
2.	Frequency meter.	1
3.	Voltmeter with selector switch.	1
4.	Remote/Local selector switch.	1
5.	Circuit breaker control switch with spring return to normal.	1
6.	Current transformer for metering.	3
7.	Current transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel).	6
8.	Current transformer for relaying.	3
9.	HRC Control fuses	8
10.	Ammeter selector switch.	1
11.	Ammeter	1
12.	Wattmeter of range 0-300 kW.	1
13.	Three pole voltage controlled definite time delay relay having current setting range of 50-200% of CT secondary current and	1

	adjustable time delay 0.3 to 3 seconds.	
14.	Watt hour meter with six (6) digits and minimum count of one (1) kWh.	1
15.	Single pole definite time over current relay having a continuous setting range of 50-200% of CT secondary current and a time delay of 2.5-25 seconds connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%.	1
16.	Three pole differential protection relay having an operating current setting range of 10-40% of generator full load current. The relay shall be of high impedance type, with necessary stabilising resistors.	1
17.	Indicating lamps with resistors and enclosed lenses.	5
18.	Push buttons for remote starting and stopping of diesel generator set (Red and green).	2

7.9 Module type H1

1.	Double pole DC switch with pad locking facility in off position.	1

7.10 Module type EL

1.	Triple pole and neutral switch	1
2.	HRC fuses	3
3.	Contactor	1
4.	Electronic timer suitable for continuous operation.	2
5.	Control Switch.	2

7.11 Module type K1

1.	Triple pole load break isolating switch (device identifier - SW) with neutral link.	1
2.	HRC fuses (device FU) and one control fuse.	3
3.	Triple pole contactor 240V AC rated (device No. 42) with hand reset thermal overload relay (device No. 49) for thermal overload relay for more than 30 kW feeder, connection through suitable current transformers may be taken.	1
4.	Auxiliary relay (device No. 42 X) 240V AC rated with 3 NO and 3 NC self reset contacts.	1
5.	Indicating lamp 240V AC rated red coloured to give motor ON indication.	1
6.	Indication lamp 240V AC rated, green coloured to give motor OFF indication	1
7.	Push button labelled (STOP).	1
8.	Push button labelled `START'	1
9.	Switch fuse unit for space heater supply for motors rated 30 kW and above.	1
10.	Current transformer and an ammeter for all motors rated 50 kW and above.	1

7.12 Module type K2 (mounted at motor)

1.	Triple pole load break isolating switch with neutral link.	1

2.	HRC fuses and one (1) Control fuse	3
3.	Triple pole contactor rated for 240V AC	1
4.	Indicating lamp 240V AC rated red/green coloured to give ON/OFF indication.	2
5.	Push button labelled STOP	1
6.	Push button labelled START	1

7.13 Module type DG- (mounted at generator)

1.	Indicating lamps	9
2.	Push buttons	7
3.	DC Ammeter (0-40A)	1
4.	DC Voltmeter (0-30V)	1
5.	Voltmeter selector switch	1
6.	AC ammeter	1
7.	AC voltmeter	1
8.	Timers (24V DC)	3
9.	Auto/Manual selector switch	2
10.	Auto/test/Manual selector switch	2
11.	CT's for metering	3
12.	PS class CT's for differential protection of diesel generator set	3
13.	Auxiliary contactors suitable for 24V DC	11
14.	Motorised potentiometer for voltage adjustment	1
15.	Battery charger as per clause no **Error! Reference source not found.** of this section	1
16.	HRC control fuses	12
17.	Set of phase and neutral busbars.	1

Module type AN (Annunciation module)

Where an integrated PC based system is not provided at the substation a central alarm annunciator shall be provided for the auxiliary power systems. The annunciation system shall consist of 30 annunciator units each having an engraved translucent plastic window of 35 mm x 50 mm (minimum) size. Engraving shall be black letters and indicate the alarm function. Annunciators shall be suitable for operation on 220V DC and shall have a single common audible alarm.

Push buttons with appropriate nameplates shall be provided for audible alarm acknowledge, alarm reset and lamp test. The push buttons shall be common to all alarm points. Annunciators shall be suitable for operation with both normally open and normally closed alarm contacts. Annunciation system shall be solid state type of reputed make.

On receiving any alarm pulse, including fleeting pulses, the appropriate alarm relay shall pick up energising the corresponding visible and audible alarm units. It shall be possible for the operator to reset the audible alarm even if the alarm condition persists. However, visible alarm shall not reset unless the alarm condition has disappeared and the reset push button is operated. Annunciator shall provide sealed in lamp indication and audible alarm shall be ready to operate

for any new alarm condition immediately after the alarm is reset push button. Annunciator shall operate satisfactorily between 80% and 110% of rated supply voltage.

Module equipment and instrumentation.

Circuit breakers, MCCB's, MCB's, selector switches, instrumentation, relays and protection equipment for LV supplies etc. shall generally conform to the requirement of the stipulated under relevant sections of this Specification.

7.14 TECHNICAL SPECIFICATION FOR INDOOR TYPE 415/240 V.A.C POWER DISTRIBUTION SWITCH BOARDS.

7.14.1 SCOPE

The specification covers manufacture, assembly and testing at manufacturer's Works, supply and delivery at site of Indoor and out door type 415/240 volts A.C. power distribution switch-boards, A.C consoles, Bay Marshalling Kiosk ,Receptacle panels complete in all respects as per system requirement for S/S and switchyards 20% spare feeders shall be provided in each Distribution Boards.

7.14.2 STANDARDS

The equipment covered by this specification shall unless otherwise specified be built to conform to Indian Electricity Rule 2956 wherever applicable and shall satisfy the requirements of the latest Indian Standard. Permissible temperature rise shall be as per relevant ISS.

7.14.3 SWITCH BOARD DESIGN

The switch board shall be self supporting, steel cubicle, compartmentalized, fully enclosed with doors for access to the interior. The switch boards shall comprise a non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear 3 mm sheet shall be used for fabrication of the panels. Modular type construction for inter-changeability will be preferred.

The complete panels shall not be more than 2450 mm. high with the channel base and 500 mm. depth measured form rear to front faces and of suitable with. The working height shall be limited to maximum 2200 mm. The design shall be such as to permit extension at site on either end. The bottom of the switch board frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plates shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboard shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and holes shall be covered with fine wire mesh from inside (for indoor use). All control and power cables will be laid in open distribution trenches running under the A.C. switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates grouting bolts, lock nuts, washer, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhesive matter or greases. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing allowed by application of an undercoat to serve as base and binder for the finishing coat. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel or dark batter ship grey, evenly sprayed to present a fine appearance while the interior faces shall be sprayed with a finishing coat of light grey paint to provide contrasting background for the wiring inside the cubicle.The internal illumination for working should be of adequate intensity CFL lamps.

A small quantity of finishing paint shall be supplied with the consignment of the Switchboards to enable the employer to restore at site any surface finish which may get damaged during transit.

7.14.4 BUS BARS

The bus bars shall be of E.G. copper/aluminum alloy, liberally sized for the specific current ratings (both short circuit and continuous currents). The size of the bus bars shall be such that the current density is not more than 1A/1.75 A per sq.mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying various phases of bus bars. Bus support shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creepage surface. Buses shall be spaced with adequate clearance between phases and phases to ground.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/riser from or to the bus bars should not be twisted but reasonable bend or joint may be allowed. The bidder shall sbsrish necessary calculations about the adequacy of sleeted bus suyyrot insulator cantilever sireugth w.r to short cicess forces.

7.14.5 AIR CIRCUIT BREAKER FOR INCOMER

A.C. air circuit breaker shall be triple pole, non-draw out type, suitable for 1100 volts grade/650 volts grade service, having continuous current carrying capacity of 400 Amps with breaking capacity of 20 KA at 415 volts. The breaker shall be provided with trip free manually operated mechanism and a push butter to trip the breaker electrically.

The breaker shall be provided with mechanical OFF/ON indicators.

The breaker shall be provided with sets of auxiliary contacts for OFF/On indicating lamps, trip circuit and inter-locking circuit along with two sets of spare contacts. The door of the circuit breaker compartment shall be so interlocked that :

i) The door cannot be opened whist the breaker is in closed opposition (i.e. 'ON')

ii) When the door is opened, the breaker shall be locked so that it can not be closed (i.e. it cannot be made 'ON'). The circuit breaker shall comply with the relevant I.S.S.

The breaker shall be complete with cable glands suitable for entry of 3 x 400 sq.mm. 1100 V/650 V grade aluminum cables.

One number 195 sq.mm. aluminum cable of same voltage grade as above shall be used for neutral, and cable gland suitable for entry of this cable shall also be provided in the switchboard. Thermal overload relay range shall be 100 Amps to 200 Amps calibrated at 55%, 75%, 100% of the height setting and suitable time settings.

Drop out and pick up voltage of the under-voltage release shall be 60% and 80% respectively of the rated voltage.

For incoming circuit 1 no. ACB(as per requirement, it differs from sub-station to sub-station) of suitable capacity according to the system should be design and furnished provided in the panel.The details of main ACDB is as below.

1) Station Transformer capacity: 33/0.433 KV, 250 KVA . Each substation there will be two nos station transformer, hence in Main ACDB there will be two incomer i.e., as source I and source II. There will be a bus coupler in main ACDB for extending the supply as and when required.

All outgoing feeders shall be provided with MCCB & SFU of suitable capacity according to the systems are to be provided.

7.14.6 INDICATING LAMPS

Indicating lamps shall be LED type provided with suitable safety resistor, and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover. The lamp holders shall preferably be screwed type.

7.14.7 SPACE HEATERS

The A.C. switchboards shall be provided with space heaters rated for 240 volts single phase A.C. Each heater shall be provided with ON/OFF switch. The wattage of the heater shall be

such as to keep 10 deg. C. above the ambient temperature during rainy season but the temperature shall not damage the wiring.

7.14.8 CABLE TERMINATION

Switchboards shall be designed to facilitate PVC cable entry from the bottom of the switchboards. Removal plates shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection.

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029" copper conductor for control and Aluminum for cables feeder up to 15 Amp. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with terminating the internal wiring and outgoing cables.

Power terminals shall be complete with lugs and control terminals shall be clamp type. Screw type terminals with screw directly impinging on conductor shall not be supplied.

Each terminal for 15 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029" copper wires at one end without any damage to the connector or any looseness of connection.

The terminal shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality. Terminal block connector built from cells of moulded dielectric and brass-stud inserts shall be provided. The connection stud shall project at least 6 mm. from the lock nut surface. All blocks shall be shrouded of easily removable shrouds moulded of transparent dielectric material of non-breakable type.

7.14.9 WIRING

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and inter-locking schemes.

All wiring shall be complete up to the terminal blocks at the factory.

Control wiring shall be carried out with flexible, heat resistant, switchboard wires. PVC insulated with 2.5 sq.mm. stranded copper conductors. Each wire shall be identified at both ends with wire destinations numbered ferrules in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points. Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminal, blocks, meters, relays, instruments, and other devices used in the switchboards. Red, Yellow, Blue and Black ferrules shall be used for Red. Yellow, Blue phases and Neutral respectively.

Wires shall be neatly bunched and adequately supported so as to prevent sagging and strain on termination.

All spare contacts of the equipment shall be wired up to the terminal block. The wiring shall be cf 1.1 KV grade. At least 20% spare terminals shall be provided.

7.14.91 Terminal connection shall be such that the conductors. LM10 may be connected by means of screw or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.

7.14.9.2 Terminal shall be such that they cannot turn or be LM10 displaced when the connecting screws are tightened and such that the conductor can also not become displaced.

7.14.9.3 Terminals should be so mounted that the appropriate wire may be connected without impairing the normal performance of the unit.

7.14.10SAFETY EARTHING

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboard shall be done with soft drawn bare copper bus. Tail connections shall have minimum area of 16

sq. mm. and the main earth connection for earth switchboard shall be brought out of two terminals for connection with the station earthing system.

7.14.10.1 Earthing terminals should be identified by means of the sign marked on a legible and indelible manner on or adjacent to the terminals.

Earthing lugs shall be provided an all earthing connections shall be carried out with green wires.

7.14.10 SWITCHBOARD LIGHTING

The switchboard illumination by providing CFL lamps and space heating arrangement to be provided.

7.14.11 INDICATING INSTRUMENT & ENERGY METERS

All instruments shall be switchboard type, back-connected, suitable for flush mounting. The construction shall conform to appropriate Indian Standard Specifications. The instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. to 50 deg. C. They shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours. All instruments shall be provided with suitable means of adjusting the accuracy in a laboratory. KWH meters specified shall be of commercial grade accuracy. Ammeter and voltmeter shall be with accuracy of +/- 1% of full scale value.

7.14.12 RELAYS

The relays shall be suitable for operation within a temperature range of 0 deg. c to 50 deg. C. The contacts of the relays shall be silvered. When open, the contacts shall withstand a voltage of 110% of the normal circuit voltage of the contacts. The relays shall not deteriorate in performance due to ageing of any constituent material.

The relays shall generally comply with the requirements of I.S.S. 3842.

7.14.13 A.C. DISTRIBUTION BOARD SCHEME

Power will be fed to A.C. distribution board through 2 Nos. incoming breakers separately from one no. 250 KVA station service transformer. Normally two feeders will feed power to two sections of A.C.D.B. coupled through a bus coupler breaker. Normally this coupler breaker will be kept upon when both the incomers are kept on. In case of failure of any one of the incomer, this bus-coupler will be made ON. These two incomers breakers and the bus coupler will be interlocked through castle interlock so that any two of the three breakers can be kept on at a time, Suitable scheme for electrical interlock and automatic switching on of the bus-coupler in the event of tripping of any of the healthy incomer is to be taken up by the bidder. Suitable annunciation for failure of A.C supply and for any of the incomer is to be provided.

A 415 V single line diagram accommodating the above facilities and to suit the system is to be design and submitted to the Employer for approval. However, exact requirement layout is to be taken up by the contractor depending on the layout, rating and type of equipment for preparation of drawing.

7.14.14 PROTECTION SCHEME FOR INCOMING CIRCUIT BREAKER

Each incoming circuit to the L.T. switchboard shall be preceded by thermal overload relays, short circuit release and over current and earth fault relays.

The breaker shall also be provided with under-voltage release of tripping out in case of supply failure.

220/240 volts D.C. operated audible as well as visible alarm with cancellation device shall be provided for the auto trip of the breakers.

7.14.15 CURRENT TRANSFORMERS

The current transformer to be provided with the incoming/outgoing circuit for metering shall be air-cooled of class 'CM' accuracy. The VA burden should be such as to suit the requirements. C.Ts shall be bar primary type moulded/cast resin type. The current transformer shall be manufactured and tested according to relevant I.S.S.

7.14.16 INSULATION LEVEL

The insulation at any point of the wiring in switchboards shall be suitable for 1100/660 volts grade service.

TEST – TYPE TEST REPORT shall be furnished.

7.15 DC supply equipment

General scheme

At 400kV and 220kV substations, each DC supply system (50V and 220V dc) shall comprise duplicate batteries and battery chargers**,** a dc distribution board and control gear. The system shall be arranged such that only one of the station batteries and one of the battery chargers shall be in service at any one time, but should either item of equipment fail or need to be taken out of service for maintenance, then the duplicate item of equipment can be brought into service without disruption of supplies. Battery chargers shall be provided with an automatic change-over facility that will operate should one of the charger units fail.

At 132kV substations, each DC supply system shall be provided with one battery and one battery charger, dc distribution board and control gear for 220V DC. However the 50V DC system shall be duplicated as in case of 400/220kV substation.

Each battery shall be either of the lead acid or alkaline type and comprise a sufficient number of cells to provide the required rating. The battery charger shall be capable of float charging the battery, from the AC supply voltage specified. A facility shall be provided for boost charging individual battery cells in situ, by means of wander leads.

The batteries shall be located in a battery room and connected to the distribution boards and battery charger located in an adjacent room via a fuse box located in the battery room.

Where the battery size is less than 200 Ah, and the cells are of the totally enclosed type, consideration will be given to housing the battery in a sheet steel cubicle mounted alongside the charger and distribution board so as to form a complete suite of panels.

The 220V DC power supplies system will operate with both battery terminals free of earth whilst that for communications equipment (the 50V DC power supply) will operate with the positive pole permanently earthed. A suitable earth fault detection scheme shall be provided.

The battery rated output shall be that available at the outgoing terminals, after making due allowance for the resistance of inter cell connections.

The battery size selected by the Contractor shall be proved by calculation which shall be subject to the approval of the Project Manager. Allowance shall be made for ageing of the battery during its service life.

Earthing of current free metallic parts on the body of the distribution boards shall be done with soft drawn bare copper bus. Tail connections shall have a minimum cross sectional area of 16 mm^2 and the main earth bar for the distribution shall be brought out to two terminals for connection to the station earth grid.

Earthing connections shall be carried out with green wire and the earthing studs shall be identified as such by an earthing symbol.

The distribution board shall be provided with 240V single phase ac illumination and anti-condensation space heaters and each heater shall be provided with an ON/OFF switch.

7.15.1 TECHNICAL SPECIFICATION FOR INDOOR TYPE 220 VOLT D.C. SYSTEM POWER DISTRIBUTION SWITCH BOARDS

7.15.2 SCOPE

This specification covers manufacture, assembly and testing at manufacturer's works, supply and delivery of Indoor Type 230 volts D.C. Power Distribution on Switchboards complete in all respects as per system requirement for 220/132/33 KV substation and switchyards. 20% spare feeders shall be provided in each DCDB.

7.15.3 STANDARDS

The equipment covered by this specification shall unless otherwise specified, be built to conform to Indian Electricity Rules 1956 wherever applicable. Permissible temperature rise shall be as per relevant ISS.

Switchboard Design

The switchboards shall be self supporting steel cubicle compartmentalized fully enclosed with doors for access to the interior. The switchboards shall comprise of non/draw out type panels placed side by side to form a continuous unit with access door for each panel at the rear. 12 SWG sheet shall be used for fabrication of the panels. Modular type construction for interchangeability will be preferred.

The complete panels shall not be more than 2250 mm. high with me channel base and 600 mm. depth measured from rear to front faces and of suitable width.

The working height shall be limited to maximum of 2000 mm. The design shall be such as to permit extension at site on either end. The bottom of the switchboard frame shall be suitable for erecting flush on concrete floor by securing it by means of evenly spaced grouting bolts projecting through the base channels. The panels shall be designed to facilitate cable entry from the bottom and removable plants shall be supplied along with the panels for this purpose which will be drilled at site to fit the cable glands.

The switchboards shall be vermin proof and suitable for use in tropical climate. All ventilating louvers and oleos shall be covered with fine wire-mesh from inside or inbuilt type. All control and power cables will be paid in open distribution trenches running under the D.C. Switchboards. The cable will enter the cubicles through entry holes of removable plates provided at the bottom of the cubicles. The successful bidder shall furnish foundation drawings for the switchboards showing the cable entry holes required and the position of the foundation bolts.

The switchboards shall be supplied complete with channel base, removable bottom plates, grounding bolts, lock nuts, washers, etc. and cable glands as specified hereafter. All unfinished surfaces of the steel panels and frame work shall be free from adhering matter or grease. A suitable rust resisting primer paint shall be applied on the interior and exterior surface of the steel housing followed by application of an undercoat to serve as base and binder. The finishing coat on the exterior of the switchboards shall be polished cellulose enamel, or dark battleship grey, evenly sparyed to present a fine appearance, while the interior faces shall be approved with a finishing coat of light grey paint to provide a contrasting background for the wiring inside the cubicle.

A small quantity of finishing paint shall be supplied with each consignment or the switchboards to enable the Employer to restore at site any surface finish which may get damaged during transit.

7.15.4 BUS BARS

The bus bar shall be of E.G. copper/aluminum alloy, liberally sized for the specified current rating (both short circuit and continuous currents). The size of bus bars shall be such that the current density is not more than (1A/1.75A) per sq. mm. for aluminum alloy and copper respectively at rated capacity. Necessary precaution shall be taken to avoid bimetallic action where copper conductors shall be connected to the aluminum bus. Means shall be provided for identifying the positive and negative bus bars. Bus supports shall be of arc resistant, non-tracking, low absorption type insulators of high impact strength and high creep age surface.

The bus and connections shall be so supported as to be capable of safety withstanding stresses due to maximum short circuit current and also take care of any thermal expansion.

The droppers/risers from or to the bus bars should not be twisted but reasonable bend or joint may be allowed.

7.15.5 MCCB/MCB

All incomer feeders will be provided with DC MCCB and all outgoing feeders with DC MCB conforming to latest IS : standards as per system requirements.

7.15.6 FUSE

Fuses shall be HRC link type of renowned make conforming to latest issue of ISS 2208. Rewirable fuses shall not be supplied.

Fuse shall be complete with fuse bases and fittings of such design as to permit easy replacement of the fuse elements.

Link shall also be easily replaceable. Visible indication shall be provides on blowing of the fuse.

7.15.7 INDICATING LAMPS

Indicating lamps shall be LED type provided with suitable safety resistor and coloured dust-tight lens. Lamps shall be of very low wattage consumption and heat generated due to continuous burning shall not deteriorate lamp cover.

7.15.8 CABLE TERMINATION

Switch boards shall be designed to facilitate PVC cable entry from the bottom of the switchboard. Removable places shall be supplied for this purpose which will be drilled at site to fit the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection

Cables shall be PVC insulated, armored and PVC sheathed with 7/0.029" copper conductor for control and for feeders up to 15 Amps. Rating. Rest of the power cable shall be of aluminum conductor of suitable size as per feeder rating.

Multiway terminal blocks of sturdy construction complete with screws, nuts. Washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

Power terminal shall be complete with lugs and control terminals shall be clamp type. Scew type terminals with screw directly impinging on conductor shall not be supplied. Connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the internal wiring and outgoing cables.

Each terminal for 25 Amps. Feeders shall be capable for connection of 2 Nos. 7/0.029" copper wires at one end without any damage to the connector or any looseness of connection. The terminals shall be properly tagged and ferruled in compliance with approved drawings. The terminal blocks shall be readily accessible and those shall be rust proof and of best quality.

7.15.9 WIRING

The wiring shall be complete in all respect so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be complete up to the terminal blocks at the factory. The insulation grade of wire to be used for internal wiring if the switch board shall be 1100 volts grade. Wiring shall be carried out with flexible heat resistant, switchboard wires PVC insulated with 2.5 sq.mm. stranded copper conductors.

Earth wire shall be identified at both ends with ferrules showing wire designations in accordance with bidder's wiring diagram. Wires shall not be spliced or tapped between terminal points.

Each wire shall be continuous and there shall not be any joint within itself. Individual wire shall be connected only at the connection terminals, blocks, meters, relays, instruments and other devices used in the switchboards. Red ferrules with positive marking shall be used for positive terminals and white

ferrule with negative marking shall be used for negative terminals for D.C. wiring.

Wires shall be beatly bunched and adequately supported so as to prevent sagging and strain on termination. All spare contacts of the equipment shall be wired up to the terminal block.

7.15.10 SAFETY EARTHING

Earthing of current free metallic parts of metallic bodies of the equipment on the switchboards shall be done with soft drawn bare copper bus Tail connections shall have minimum area of 26 sq. mm. and the main earth connection for each switchboards shall be brought out to two terminals for connection with the station earthing system.

Earth terminals should be identified by means of the sign marked in a legible and indelible manner on or adjacent to the terminals. Earth lugs shall be provided and all earthing connections shall be carried out with green wires.

7.15.11 SWITCH BOARD LIGHTING

The interior of each panel switchboard shall be illuminated by CFL lamps connected to 230 volts. Single phase A.C. supply and shall be controlled by a door-operated swich. All A.C. wiring shall be carried out with black wires. The incoming A.C. supply to the D.C. boards shall be provided with H.R.C. fuse and link of proper rating.

7.14.17 INDICATING INSTRUMENTS

All instruments shall be of switchboard type, back-connected suitable for flush mounting. The construction shall conform to the appropriate Indian Standard Specifications. The instruments shall be capable of indicating freely without error when operated continuously at any ambient temperature from 0 deg. C to 50 deg. C. Those shall withstand the effects of shock, vibration and humidity. All circuits of instruments shall be capable of withstanding 20% overload for a period of at least 8 hours.

7.15.13 COMPLETENESS OF SUPPLY

The switchboards offered by the bidder shall be complete in all respects. Any materials necessary which may not have been specifically mentioned but which is usual or necessary for satisfactory and trouble-free operation and maintenance of the switchboards shall be supplied without any extra charge to the employer.

7.15.14**SPARES**

The item wise price for the spares recommended for three years operation and maintenance of each switchboard shall be quoted.

7.15.15**INTER CHANGEABILITY**

All similar materials and removable parts shall be interchangeable with each other.

All switches, contactors, etc. shall be easily removable as a complete unit from the switchboards and shall be capable of being put in similar position in other switchboards for performing identical functions.

The spares called for in respective sections shall be identical with like parts provided in the main equipments in all respects and shall be capable of replacing the main equipments wherever required to carry out identical functions.

7.15.16**ACCEPTABILITY OF DIFFERENT EQUIPMENTS & AUXILIARIES**

All equipments, cables, wires and accessories offered shall be of best quality and of renowned make for successful and trouble free operation of the switchboards.

Equipments/accessories of substandard quality shall not be accepted by the Employer.

7.15.17**TESTS**

The following tests are to be carried out.

i) Checking continuity of the wiring.
ii) Insulation resistance of all wiring circuit with all equipments mounted on the board, before and after application of H.V.
iii) One minute power frequency voltage withstand test. All equipments and wiring shall withstand a power frequency voltage of 2 KV applied between any circuit and earth.
iv) Routine test of all equipments, switches and devices according to relevant I.S.S.
v) Type test reports shall be furnished.

7.15.18**CLEARANCE**

The apparatus forming part of the panel shall have requisite clearances and these shall be maintained during normal service conditions. When arranging the apparatus within the panels, the clearances for them shall be complied with taking into account the relevant service condition. In addition, abnormal conditions such as in short circuit shall not permanently reduce the distances between bus bars.

7.15.19**NAME PLATE OF D.C. SWITCHBOARDS**

Each panel shall be provided with name plates, marked in a durable manner and located in a place such that they are visible and legible when the panel is installed. The following information should be given on the name plate.

a) The manufacturer's name and /or 'trade mark' & identification number.
b) Rated operational voltage.
c) Purchase order number and date.
d) Weight.

7.15.20**D.C. SYSTEM**

The 220 volts .D.C. supply will be available from the lead acid station storage battery banks associated with battery charging equipment.

In the 220 KV system the D.C. supply will be available from two sources. So the system should be designed with provision for a bus coupler.

The battery shall normally float under trickle charge conditions with the charger which continuously supplies the D.C. load to the load bus in D.C. switchboard and trickle charging current to the battery. The charger will be connected to the bus through double pole switch fuse unit. These two double pole switch unit should be mechanically interlocked so that only one switch can be closed at a time. An emergency D.C. lighting system would be provided in each sub-station to operate a separate lighting system with D.C. power in case of total failure of A.C. supply. The D.C. lighting system would be completely independent from the normal A.C. lighting system. For this purpose, provision shall be made in the panel for main failure contactors with contacts rated for 32 Amps. And a switch on emergency lighting circuit across the D.C. but in the vent of main failure. The two switch fuse units required for D.C. lighting feeders shall be taken from the D.C. panel Board. D.C. fail alarm both audible and visual shall be provided in case of total failure of D.C. supply at the load bus as per drawing. 220 volts D.C. system single line diagram (No.SWG/570) is enclosed in Section-8 for guidance and understanding of D.C. system. As the entire D.C. system is to be designed by the contractor depending on the rating and type of equipment being supplied, the necessary modification in the schematic diagram has to be taken up by the contractor and got approved from the Engineer.

8. BAY MARSHALLING KIOSK:

8.1: Same as ACDB but out door type. The purposes of these boards are to be installed in the switch yard at different locations. There shall be two incomer as source I and source II. There shall be adequate AC out lets both 3 phase with neutral and single phase, which will be taken to all the equipments and equipment marshalling boxes. At lest 20% extra outlets are to be provided besides the requirement to meet during exigencies. All the inlet and out lets shall be provided with MCB's. The board shall have two doors one at front and the other at the rear end. Since these boards are to be installed out side in the switch yard sufficient care as per the

relevant standards are to be taken care fomr weathering effect. At the front end all AC inlets and out lets are to be provided and at the rear end terminal blocks are to be provided in column wise for DC control /AC control purpose. The minimum quantity of terminal blocks of rating 20 Amps shall be 300 nos with duly marked the number of terminals. At the front side also adequate capacity (current rating) as per the rating of MCB terminal blocks to be provided for inlet and out let points of AC supply.

8.2 Proper engineering to be made and to be submitted for approval to OPTCL before manufacturing and supply. The components and wirings to be used shall be of as per IS standard and of reputed make.

9. AC CONSOLES:

9.1: Same as ACDB but out door type suitable for use in switchyard illumination control. Adequate nos of MCB,s for incoming and outlets are to be provided in the console to take care of the switch yard illumination system. No of such boards will be as per requirement. Care should be taken as these boards are of outdoor type. 20 % extra outlets should be provided to meet the exigencies.

10. RECEPTACLE AC SUPPLY PANEL:

10.1: Receptacle panels both indoor and out door types are to be provided to meet the emergency requirement of AC supply. For example welding purpose, testing purpose etc. Both three phase and single phase out lets should be provided. One no receptacle panels outdoor type shall be provided near the transformer for oil filtration purpose. The rating of the inlet and out let MCCB, s shall be 250 Amp.

(A) DETAILS OF DISTRIBUTION BOARDS: (FOR 400/220 KV & 220/132 KV SUB-STATION)

1) MAIN ACDB:

a) Incomer - 1: 800 Amp/1600 Amp, 50KA, draw out type, Microprocessor Control, ACB. It shall contain 3 O/C & E/F relays with high setting provision, UV relay, Electrical Close/Open facility for ACB,ON/OFF lamp indication, Auto trip indication, TC healthy indication with P.B, Spring charge indication, R,Y,B healthy indication, Ammeter & voltmeter with selector switch, Annunciation facia with Acc, Reset and Test P.B.

b) One Bus-coupler: Same as Incomer 1 above.

c) Incomer – 2: Same as Incomer – 1 above.

d) Out going Feeders: (For Incomer – 1) ,1)250 Amp MCCB: 4 Nos,
2) 100 Amp MCCB: 4 Nos, 3) Spare compartment: 2 Nos.

e) Out going Feeders: (For Incomer – 2) , 1)250 Amp MCCB: 4 Nos,
2) 100 Amp MCCB: 4 Nos,3) Spare compartment:2 Nos

2) ACDB: R,Y,B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 250 Amp MCCB and 250 Amp MCCB for DG incomer.(with interlocking facility.

b) Out going feeder(for inc 1): 1) 63 Amp MCCB : 16 Nos 2) 32 A MCCB: 8 Nos

c) Bus coupler: 250 Amp MCCB

d) Incomer -2: 250 Amp MCCB and 250 Amp MCCB for DG incomer. (With interlocking facility.

e) Out going feeder (for Inc 2): 1) 63 Amp MCCB: 16 Nos 2) 32 A MCCB: 8 Nos

3) MAIN LIGHTING DB: R, Y, B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 250 Amp MCCB.

b) Out going feeder (for inc 1): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

c) Bus coupler: 250 Amp MCCB

d) Incomer -2: 250 Amp MCCB

e) Out going feeder (for Inc 2): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

4) INDOOR RECEPTACLE DB: R,Y,B Healthy indication.

a) Incomer: 63 Amp MCB

b) Out going: 32 Amp ,3 Phase,MCB: 2

c) Out going: 32 Amp ,1 Phase,MCB: 4

5) EMERGENCY LIGHTING DB:

a) Incomer: 100 Amp MCCB
b) Out going: 63 Amp ,3 Phase,MCB: 2
c) Out going: 32 Amp ,1 Phase,MCB: 4
d) Out going: 16 Amp ,1 Phase,MCB: 8

6) 220 V DC Indoor Ltg. DB:

a) Incomer : 32 Amp DC MCB from DCDB with auto changeover facility having delay timer with auto/manual selection switch.
b) Outgoing feeder: 16 Amp DC MCB: 5 Nos

7) 220 V DCDB (SET):

7.1) 220 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
a) Incomer: 100 Amp DC MCCB:
b) Out going: 100 Amp DC MCCB : To couple the other DCDB
c) Out going feeder: 32 Amp DC MCB: 20 Nos.

7.2) 220 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
a) Incomer: 100 Amp DC MCCB:
b) Out going: 100 Amp DC MCCB : To couple the other DCDB
c) Out going feeder: 32 Amp DC MCB: 20 Nos.
(* 220 V DCDB-1 & 220 V DCDB-2 combined shall be treated as 220 V DCDB).

8) 48 V DCDB (SET):

8.1) 50 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
a) Incomer: 100 Amp/250 Amp DC MCCB:
b) Out going: 100 Amp/250 Amp DC MCCB: To couple the other DCDB
c) Out going feeder: 32 Amp DC MCB: 20 Nos.

8.2) 50 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.
a) Incomer: 100 Amp/250 Amp DC MCCB:
b) Out going: 100 Amp/ 250 Amp DC MCCB: To couple the other DCDB
c) Out going feeder: 32 Amp DC MCB: 20 Nos.
(* 50 V DCDB-1 & 50 V DCDB-2 combined shall be treated as 50 V DCDB)

9) BMK (Suitable for Outdoor type) (Provision of telephone jack points)

a) Incomer : 63 Amp TP MCB : 1 for source - 1 and 1 for source -2 (with timer,for auto changeover, contactors (two nos each rated 70 Amp) suitable to take care of changeover automatically.)
b) Out going feeder: 16 Amp TP MCB : 10 Nos , 10 Amp DP MCB: 8 Nos (at Front side)
c) 300 Nos of Terminal Block of Elmex/ any renowned make suitable for 35 Amp rated.

10) OUTDOOR RECEPTACLE DB: (Transformer filtration purpose)

a) Near Transformer: Incomer 250 Amp MCCB: 1 No., Outgoing: 250 Amp MCCB : 1 No., Having provision of R,Y,B indication. (For transformer oil filteration)
b) Inside switch yard at Different location: Incomer: 63 Amp TPN MCB, Out going feeder: 2 Nos 32 Amp TP MCB and 2 Nos 16 Amp DP MCB.

All outdoor kiosk top cover shall be of Aluminum alloy having 3mm thickness & proper sloping shall be maintained for easy drainage of water.

(B) DETAILS OF DISTRIBUTION BOARDS: (FOR 132/33 KV SUB-STATION)

1) MAIN ACDB:

a) Incomer - 1: 800 Amp Amp, 50KA, draw out type, Microprocessor Control, ACB. It shall contain 3 O/C & E/F relays with high setting provision, UV relay, Electrical Close/Open

facility for ACB,ON/OFF lamp indication, Auto trip indication, TC healthy indication with P.B, Spring charge indication, R,Y,B healthy indication, Ammeter & voltmeter with selector switch, Annunciation facia with Acc, Reset and Test P.B.

b) One Bus-coupler: Same as Incomer 1 above.

c) Incomer – 2: Same as Incomer – 1 above.

INCOMER -1:

(a) 250 Amp TPN MCCB: 2 Nos. and (2) 250 Amp TPN MCCB for DG incomer.(with interlocking facility.

b) Out going feeder : 1) 63 Amp TP MCCB : 16 Nos (3 phase). 2) 32 A TP MCB: 8 Nos (3 phase)

c) Out going feeder: (1) 100 Amp TP MCCB: 02 Nos.(3 phase)

d) Out going feeder: 32 Amp DP MCB (1 phase)

INCOMER -2:

(a) 250 Amp TPN MCCB: 2 Nos. and (2) 250 Amp TPN MCCB for DG incomer.(with interlocking facility.

b) Out going feeder : 1) 63 Amp TP MCCB : 16 Nos (3 phase). 2) 32 A TP MCB: 8 Nos (3 phase)

c) Out going feeder: (1) 100 Amp TP MCCB: 02 Nos.(3 phase)

d) Out going feeder: 32 Amp DP MCB (1 phase)

2) MAIN LIGHTING DB: R, Y, B Healthy Indication, Ammeter and voltmeter with selector switch.

a) Incomer -1: 250 Amp MCCB.

b) Out going feeder (for inc 1): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

c) Bus coupler: 250 Amp MCCB

d) Incomer -2: 250 Amp MCCB

e) Out going feeder (for Inc 2): 1) 63 Amp MCCB: 4 Nos 2) 32 A MCCB: 2 Nos

3) INDOOR RECEPTACLE DB: R,Y,B Healthy indication.

a) Incomer: 63 Amp MCB

b) Out going: 32 Amp ,3 Phase,MCB: 2

c) Out going: 32 Amp ,1 Phase,MCB: 4

4) EMERGENCY LIGHTING DB:

a) Incomer: 100 Amp MCCB

b) Out going: 63 Amp ,3 Phase,MCB: 2

c) Out going: 32 Amp ,1 Phase,MCB: 4

d) Out going: 16 Amp ,1 Phase,MCB: 8

5) 220 V DC Indoor Ltg. DB:

a) Incomer : 32 Amp DC MCB from DCDB with auto changeover facility having delay timer with auto/manual selection switch.

b) Outgoing feeder: 16 Amp DC MCB: 5 Nos

6) 220 V DCDB (SET):

6.1) 220 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

a) Incomer: 100 Amp DC MCCB:

b) Out going: 100 Amp DC MCCB : To couple the other DCDB

c) Out going feeder: 32 Amp DC MCB: 20 Nos.

6.2) 220 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

a) Incomer: 100 Amp DC MCCB:

b) Out going: 100 Amp DC MCCB : To couple the other DCDB

c) Out going feeder: 32 Amp DC MCB: 20 Nos.

(* 220 V DCDB-1 & 220 V DCDB-2 combined shall be treated as 220 V DCDB).

7) 48 V DCDB (SET):

7.1) 50 V DC DB:1: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

a) Incomer: 100 Amp/250 Amp DC MCCB:

b) Out going: 100 Amp/250 Amp DC MCCB: To couple the other DCDB

c) Out going feeder: 32 Amp DC MCB: 20 Nos.

7.2) 50 V DC DB:2: Having Earth fault relay (Earth leakage), Under and over voltage, DC Ammeter and Voltmeter. Annunciation scheme.

a) Incomer: 100 Amp/250 Amp DC MCCB:

b) Out going: 100 Amp/ 250 Amp DC MCCB: To couple the other DCDB

c) Out going feeder: 32 Amp DC MCB: 20 Nos.

(* 50 V DCDB-1 & 50 V DCDB-2 combined shall be treated as 50 V DCDB)

8) BMK (Suitable for Outdoor type) (Provision of telephone jack points)

a) Incomer : 63 Amp TP MCB : 1 for source - 1 and 1 for source -2 (with timer,for auto changeover, contactors (two nos each rated 70 Amp) suitable to take care of changeover automatically.)

b) Out going feeder: 16 Amp TP MCB : 10 Nos , 10 Amp DP MCB: 8 Nos (at Front side)

c) 300 Nos of Terminal Block of Elmex/ any renowned make suitable for 35 Amp rated.

9) OUTDOOR RECEPTACLE DB: (Transformer filtration purpose)

a) Near Transformer: Incomer 250 Amp MCCB: 1 No., Outgoing: 250 Amp MCCB : 1 No., Having provision of R,Y,B indication. (For transformer oil filteration)

b) Inside switch yard at Different location: Incomer: 63 Amp TPN MCB, Out going feeder: 2 Nos 32 Amp TP MCB and 2 Nos 16 Amp DP MCB.

All outdoor kiosk top cover shall be of Aluminum alloy having 3mm thickness & proper sloping shall be maintained for easy drainage of water.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

CONTROL AND RELAY PANEL

PROTECTION AND CONTROL PANELS

1.0 Panels

General

Simplex and/or duplex panels shall be provided to suite the substations site. Bidder shall be fully responsible for his bids to match the dimensions, colour and fittings with those in the existing control rooms where the extensions are required. In no case any proposal for increase in price at a later date shall be entertained by the Employer. However panels not matching those already installed may be acceptable to the Project Manager. Specific approvals will be required on a case by case basis.

Panels shall be free standing mounted on floors fitted with embedded channels, insert plates or foundation bolts. The panels shall be made vibration and shock proof by providing anti vibration strips.

The base frame of all panels shall have a smooth bearing surface such that when fixed on the embedded foundation channels/insert plates it shall be free standing and provide a level surface.

The panels shall be completely metal enclosed, dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS 13947

The design, materials selection and workmanship shall be such that it provides a neat appearance both inside and outside without signs of welds, rivets or bolt heads from outside. The exterior surfaces shall be smooth and sleek.

Relay panels of modern modular construction in 19 inch hinged racks would also be acceptable.

Cable entry to the panels shall be from the bottom. The provision of all cable glands and shrouds of the panel shall be part of the scope of supply. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor.

1.1 Simplex Panel

Simplex panels shall be provided with equipment mounted on front panel vertically. The wiring access shall be from rear for control panels and either from front or rear for relay panels. Where panel width is more than 800 mm, double leafed doors shall be provided. Doors shall be fitted with either built-in locking facility or with padlock.

1.2 Duplex Panel

Duplex panels shall be walk-in, tunnel type comprising of two vertical front and rear panels connected back to back by formed sheet steel roof as tie members and a central corridor in between. The corridor shall facilitate access to internal wiring and external cable connections. Where a number of duplex panels are located in a row side by side, the central corridor shall be aligned to form a continuous passage. Both ends of the corridor shall be provided with double leaf doors with lift off hinges. Doors shall be fitted with either built-in locking facility or with padlock. Separate bottom cable entries shall be provided for the front and rear panels. The inter-connections between front and back panels shall be established by providing wiring at the top of the panel.

IMP: Only Relay panel front side should be provided with protective front door with PRESPEX cover with flush type handle with locking facility to protect the relays from the external.

1.3 Constructional Features

It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes can be properly accommodated in the panels without congestion. Panels shall be free standing, floor mounting type and shall comprise of structural frames completely enclosed with smooth finished, cold rolled sheet steel of thickness not less than 3 mm for all weight bearing members such as base frame, front panel, door frames. All other parts may be provided with 3.0 mm thick steel sheet. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation. All doors, removable covers and panels shall be gasketted all around with neoprene or superior material. Ventilating louvres, where provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

1.4 Mounting

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices. Equipment shall be readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible. The Contractor shall carry out cut-out,

mounting and wiring of all equipment and items which are to be mounted in his panel. Cut-outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plates. The center lines of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. The top lines of all meters, relays and recorders etc. shall be matched. No equipment shall be mounted on the doors. All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage which may be caused by fire.

1.5 Terminal Blocks

Terminal blocks and boards shall conform to the requirements of the relevant sections of this Specification. De-link type terminal blocks shall be provided in all the circuits and Terminals.

1.6 Supporting steel

All necessary embedded levelling steel, sills, anchor bolts, channels and other parts for supporting and fastenings the panels and vibration damping shall be supplied by the Contractor.

Instruments, Meters, Recorders and Transducers

2.0 General

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All indicating instruments and recorders shall be digital type and provided with individual transducers and shall be calibrated along with the transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have a means of calibrations check and adjustment at site. The Contractor shall confirm that the indicating instruments, recorders along with transducers and energy meters offered by him are suitable for connecting to the instrument transformers having the technical particulars given in reference drawing. Synchronizing Instruments shall also meet the requirements of the relevant clause of this section of the Specification. Digital bus voltage and frequency meters shall be of class 0.5 and shall have digital readouts of five and four digits respectively, with display size, not less than 50 mm (height)

2.1 Metering Instruments

Energy-meters **(NOT REQUIRED)**

Energy meters shall be provided on all line feeders, transformer feeders, buscoupler and bus transfer bays as per the requirements stated in the schedule of requirement of this specification.

On 400/220/132 kV feeders emanating from various substations, where commercial metering is required redundant energy metering in form of MAIN shall be employed.

All 33 kV feeders emanating from various substations shall be treated as feeders with commercial metering requirements. Only single energy meters shall be employed.

Energy meters shall be solid state tri vector type. The energy meters are intended to measure, record and display active energy (kWh/MWh), reactive energy (kVARh/MVARh), apparent energy (kVAh/MVAh), Maximum Demand (MVA/kVA/MW/kW/ etc. They should be of three phase two element type or three element type suitable for measurement of unbalanced loads in three phase, three wire circuits. The meters shall be provided with at least six registers for TOD metering purposes. The meters shall have LCD or cyclometer type registers.

Energy meters shall be of draw out or non-drawout type and suitable for flush mounting with back connected terminals.

Energy meters shall be suitable for operation from the secondary of CT's and VT's. Separate test blocks for the testing of the meters (without disturbing the CT and VT secondary connections) shall be provided.

Energy Meters shall have reverse running stops. Meters shall conform to IEC 687 /IS 13779. All watt-hour meters shall have accuracy class of 0.2. All VARh-hour meters shall have accuracy class of 3.0. The energy meters shall also conform the requirements stipulated in Technical Report of Central Board of Irrigation and Power, India.

Energy Meters shall be compensated for temperature errors and factory calibrated to read the secondary quantities. The number of digits provided shall be adequate to cover at least 1500 hours of operation.

Current coils of the meters shall have continuous overload capacity of at least 200% for both accuracy and thermal limits, and shall withstand at least 20 times of rated current for 0.5 seconds without loss of accuracy.

Energy meters should have facilities for data transfers remote metering with proper security via an optically isolated communication port using serial communication. Where required, output ports shall be provided for summation and time synchronisation.

Energy meters shall be provided with features for monitoring tamper and fraud. The possible cases of tamper and fraud shall be proposed by the Project Manager to Contractor for incorporation in to the metering software.

Energy meters should be provided with adequate software and hardware to store the load survey data from the last reset time. Energy meters shall also be provided with self diagnostic features.

Technical requirement for energy meters

Description	**Requirement**
Operating voltage	110V Phase to phase, 65.3V Phase to neutral
Operating current	1—5 A
Measurement	Real and reactive energy Maximum demand Bi-directional power flow
Display	Digital type (electronic type). In case of electronic type of display the minimum retention time for non volatile memory shall not be less than 5 years
Communication	Optical Port / E— Port

Table 9.3.2. Technical requirements for energy meters

2.2 Recording instruments

Recording instruments shall have the following characteristics features :

- Static/Digital type voltage and frequency recorders in individual units for the sub-station with time tagged information shall be acceptable. It shall meet the accuracy of +/-:1.0% span and full span response time of less tha 2 seconds. It shall also meet the high voltage susceptibility test,impulse voltage withstand test,high frequency disturbance test – class III and fast transient disturbance test leve III as per IEC 602555.

2.3 Transducers

General

The transducers used for recording/indicating instruments and telemetry/data communication applications shall in general conform to IEC 688-1.

Transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase, four wire system. These could be separate or combined type. Serial port on combined type is also acceptable.

The input to the transducers will be from substation current and potential transformers. The output shall be in milli ampere DC proportional to the input. It shall be possible to feed the output current directly to the telemetry terminals, indicating instruments or recording instruments.

The transducer characteristic shall be linear throughout the measuring range.

The transducer output shall be load independent.

The input and output of the transducers shall be galvanically isolated.

The transducer shall derive its auxiliary supply from the quantity to be measured without need for any external supply.

Each transducer shall be housed in a separate compact case and have suitable terminals for inputs and outputs. Input side terminal connectors (from CT's and PT's) to be suitable for three phase, four wire connection.

The transducers shall be suitably protected against transient high peaks of voltage and current.

The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 200% of the rated input current as applicable.

Voltage, frequency and current transducers associated with the ISCS shall have an output to 0-10 mA and the active and reactive power transducers shall have an output of 10-0-10 mA.
Voltage, frequency and current transducers associated with conventional systems shall have an output to 4-20 mA and the active and reactive power transducers shall have an output of 10-0-10 mA.

The response time of the transducers associated with ISCS shall be less than 500 milliseconds. Response time for transducers associated with conventional systems shall be less than one second.

The transducers shall have a working temperature range of 0-50C.

The accuracy class of transducers shall be 0.5 or better except for frequency transducer which shall be 0.2.

The transducers shall have an AC ripple on output of less than 1%

The transducers shall be suitable for load resistance of 1000-1500 ohms

The CT and PT ratios and scale ranges for the voltage, current and frequency transducers shall be suitable for the various CT and PT ratios (as applicable) furnished with the specification and compatible with the feeder/transformer voltage levels and ratings.

The transducer shall be provided with terminal connectors for wire of maximum cross section of 4 mm., with dual screws, for rigid connections.

The transducer shall have dual output.

Transducers (recording/indicating instruments and telemetry/data communication application)

The transducers shall in general conform to IEC 688-1 and have the following features:

- Each transducer shall be housed in a separate compact case and have suitable terminals for inputs and outputs.
- The transducers shall have an output of 4-20 mA.
- The response time of the transducers shall be less than one second.
- The accuracy class of transducers shall be 0.5 or better except for frequency transducer which shall be 0.2.
- The PT ratios and scale ranges for the voltage and frequency transducers shall be as follows:

	PT Ratio	**Scale range**
Voltage transducer :	400kV/110V	0-500kV
	220kV/110V	0-300kV
	132kV/110V	0-200kV
	33kV/110	0-50kV
Frequency transducers :	as above	45-55 Hertz.

All the transducers shall be suitable for CT and PT parameters specified.

- The transducer shall have dual output.

2.4 Annunciation System:

General

The annunciation shall be of visual and audible type. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels. The audible alarm shall be provided by alarm buzzer or bell. The annunciation facia shall be provided with translucent plastic windows for alarm points with minimum size of 35 mm x 50 mm. The facia plates shall be engraved in black lettering with inscriptions. The list of such inscriptions shall be furnished by the Contractor for the Project Manager's approval. The inscriptions shall be engraved on each window in not more than three lines with letter sizing not less than 5 mm. Where annunciation systems are already provided, the annunciation scheme shall be engineered as an extension to the existing scheme. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The lamp circuit shall include series resistor of adequate rating. The cover plate of the facia windows shall be flush with the control panel and shall be capable

of easy removal to facilitate replacement of lamps. The cover plate transparency and the lamps wattage in the fascia windows shall be designed to ensure clear visibility of the inscriptions in the control rooms (having an illumination level of 350 lux) from the location of the Operator's desk.

TRIP and **NONTRIP** facia shall be differentiated. All **TRIP** facia shall have red colour and all **NONTRIP** fascia shall have green colour.
Sequence of operation of the annunciator shall be as given in Table 10.1.

Alarm Condition	**Fault Contact Status**	**Visual Annunciation**	**Audible Annunciation**
Normal	Open	OFF	OFF
Abnormal	Close	Flashing	ON
Accept push button is pressed	(a) Close (b) Open	Steady on Steady on	OFF OFF
Reset push	(a) Close (b) Open	ON ON	OFF OFF
Lamp test push button pressed	Open	Steady on	OFF

Table 10.1. Sequence of annunciator operation

Visual and audible annunciation for the failure of DC supply to the annunciation system shall also be provided and this annunciation shall operate on 240 Volts AC supply with separate fuses. On failure of the power supply to the annunciation system for more than two or three seconds (adjustable setting) a facia shall light up and an audible alarm shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone, however the facia window shall remain steadily lit till the supply to the annunciation system is restored. The sound of the audible alarm (bell) provided for this annunciation shall be different from the audible alarm provided for the annunciation system.
A separate voltage check shall be provided to monitor the failure of supply (240V AC) to the scheme mention above. If the failure of supply exists for more than two to three seconds this relay shall initiate visual and audible annunciation.
The annunciation system shall be capable of catering to at least 20 simultaneous signals at time.
One self resetting push button shall be provided on each panel for testing the facia window lamps. Push buttons for testing flasher and audible alarm circuits of the annunciation system and for testing the annunciation supply failure monitoring circuit shall be provided. These testing circuits shall be so connected that while testing is being done it shall not prevent the registering of any new annunciation that may occur during the test.
One set of the following push buttons shall be provided on each panel as shown in the sample front view drawing attached to this Specification.

- Reset push button for annunciation system.
- Accept push button for annunciation system.

The annunciation shall be repetitive type and shall be capable of registering fleeting signals. Minimum duration of the fleeting signal registered by the system shall be 15 milliseconds.
Auxiliary relays for the annunciation system shall have adequate auxiliary potential free contacts for use in event logger.

The annunciation shall be suitable for operation with normally open contacts which close on a fault or contacts which open on a fault. It shall be possible at site to change annunciators from "close to fault " to " open to fault " and vice-versa.
In case of a static annunciator scheme, special precautions shall be taken by Contractor to ensure that spurious alarm conditions do not appear due to the influence of external electro magnetic or electrostatic interference on the annunciator wiring, and switching disturbances from the neighbouring circuits within the panels.
Annunciation systems to be supplied for existing substations should be matched with the existing scheme in co-ordination with the Project Manager during detail engineering stage.

2.5 PANEL INTERNAL WIRING

1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally
2. All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC insulation. The m minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows.
3. All circuits except current transformer circuits and voltage transfer circuits meant for energy metering one 2. sq. per lead.

4.1 All current transformer circuits one 4.0 sq. mm lead.

4.2 Voltage transformer circuit (for energy meters): Two 2.5 mm sq per lead.

4.3. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5. Wire germination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

4.8. All wiring shall be switch board type single conductor tinned annealed copper wire insulated with varnished cambric, faulted asbestos, single braided cotton cover painted overall with flame proof moisture resistant paint and suitable for 660 volt service or equivalent polyncychloride insulation which has proved its utility in tropical regions against hot and moist climate and vermin (Misc. white ants and cockroaches etc) Rubber insulated wiring will not be accepted. The sizes of wiring in different circuits shall not be less than those specified below

Table – I

Circuit	Minimum permissible Size of wire.
Metering and relaying circuits connected to Current Transformers.	4.0 mm sq.
Potential circuits for metering and Relaying,	4.0 mm sq.
Other control, visual and audible alarm signaling circuits etc.	2.5 mm sq

The following colour scheme shall be used for the wiring.

Table – II

Circuit where use.	Colour of wire and ferrule.
Red phase of instrument transformer circuit	Red.
Yellow phase of instrument transformer	Yellow.
Blue phase of instrument transformer circuits	Blue.

Neutral connections earthed or not earthed in the instrument transformer circuit	Green.
A.C. Control wiring circuits using D.C. upply	Grey

All wiring inter-connecting the front cubicles with the rear cubicles of the panel board over the access corridor shall be wired in gutters held against the ceiling of the corridor by means of screws. All potential bus wiring, audible alarm bus wiring, AC and DC control supply bus wiring, wiring for cubicles lighting and such other wiring which funs from cubicle to cubicle within the switch board shall be laid out in gutters and shall be carefully screened. As the front and rear cubicles with be detachable, the inter-connection shall be made through suitable terminal connectors securely fixed on the panel.

Wiring connected to the space heaters in the cubicles shall have porcelain braided insulation over a safe length from the heater terminals.

Each wire shall be continuous from end to end without having any joint within itself. Individual wires shall be connected only at the connection terminals or studs of the terminal blocks, meters, relays, instruments and other switchboard devices.

Terminal ends of all wires shall be provided with numbered ferrules suitable coloured (Ref : Table-II) for phase identification. At point of inter/connection where a change of number is necessary, duplicate ferrules shall be provided with the appropriate numbers on the changing end.

At the terminal connection, washers shall be interposed between terminals, wire terminals and the holding nuts. All holding nuts shall be secured by locking nuts. The connection stud shall project at least 6 mm. from the lock nut surface.

Wire ends shall be so connected at the terminal studs that no wire terminal number ferruled gets masked due to succeeding connections. All wires shall be suitable for bending to meet the terminal stud at rectangles with the stud axis, and they shall not be skewed.

All studs, nuts, bolts, scores, etc. shall be threaded according to the British Standard practice unless Employer's prior approval to any other practice of threading is obtained. Spare quantities of nuts, lock nuts and washers of all varieties used on the panel board shall be supplied to the extent of 10% of the used quantities.

2.6 TERMINAL BLOCKS

All the terminal blocks to be used in the panel shall be provided with 1100V grade stud type terminal block of Polyamide material of Elmex) / Connectwell. At least 20% spare terminals shall be provided.

(i) All internal wiring to be connected to external equipment shall terminate on terminal blocks. Disconnecting type Terminal blocks shall be 1100 V grade and have 20 Amps. Continuous rating, molded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts,. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

(ii) Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short-circuiting and earthling facilities.

(iii) At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

(iv) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side.

(v) There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel sidewall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm

(vi) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallels and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the owner's external cable connections. All adjacent terminal blocks shall also share this field-wiring corridor. All wiring shall be provided withadequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

(vii) The number and sizes of the Owner's multi core incoming external cables will be furnished to the contractor after placement of the order. All necessary cable-terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of suppl

2.7 PAINTING:-

Powder coating type is preferable.

All sheet steel work shall be phosphated in accordance with the IS:6005 Code of practice for phosphating iron and steel.

(1)All unfinished surface of the steel panels and frame work shall be sand blasted to remove rust, scale, foreign, adhering matter of grease.

(2) A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel, which shall be followed by application of an under coat suitable to serve as base and binder for the finishing coat. The finishing coat on the exterior of the panels shall be deep gray powder coated. Polished cellulose appearance while on the interior faces the finishing coat shall be of light gray shaded paint sprayed to give a contrasting effect with the cubicle wiring.

A small quantity of finishing paint shall be supplied with each consignment of the panels to enable the Employer's store at site any finish which may get damaged curing the transshipment. The panel boards may alternatively be given a plastic durable covering coat for protection of the finish during the transshipment, which shall be capable of being peeled off after installation.

2.8 TERMINAL BLOCK CONNECTION

Terminal Block connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the outgoing ends of the cubicle wiring and the corresponding incoming tail ends of the control cables.All the terminal connectors shall have de-link(disconnecting) facilities.

Provision shall be made on each pillar for holding 20% extra connection (10% incoming + 10% outgoing). All blocks shall be shrouded by easily removable shroud molded of transparent dielectric materials. The terminal blocks shall be suitable for 660 volts service and connection with both aluminum and copper cable.

2.9 SPACE FOR CONTROL CABLES AND CABLE GLANDS

Sufficient space for receiving the control cables inside the board at the bottom of the cubicles and mounting arrangement for the terminal cable glands shall be provided. The specification does not cover supply of control cables and cable glands for which the employer will make separate arrangement.

2.10 SPACE HEATERS

60 W. 240 V. 50 HZ tubular space heaters with thermostat auto suitable for connection to the single phase AC supply complete with on-off switches located at convenient positions shall be provided at the bottom of the switch board cubicle to prevent condensation of moisture. The watt loss per unit surface of heater shall be low enough to keep surface temperature well below sensible heat.

2.11 DISTRIBUTION AND CONTROL OF AUXILIARY POWER CIRCUIT

2.11.1 D.C. CIRCUIT

There shall be separate D.C. incomers for the each control and relay board panel fed from D.C. distribution boards through a suitable fuse switch unit, provided there. M.C.B,s. of required Amps rating shall be provided in the panel as D.C. incomer (source I one number and source II one number). A continuous D.C. bus shall be provided in the control and relay board panel and D.C. supply for control, protection, supervision and indication of circuit breaker and other equipments shall be teed off in each panel from D.C. bus through a set of HRC Fuse (both on +ve and –ve side) D.C. supply to individual panel thus teed off shall be distributed within the panel as below.

2.11.2 **SWITCHES & FUSES**:

Each panel shall be provided with necessary arrangement for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with fuses. The selection of the main and sub circuit

fuses rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC catridge type confirming to IS: 3703 mounted on plug in type fuse bases. The short time fuse rating of fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse rating and voltage.

A D.C. operated no-volt, auxiliary relay provided with hand reset reverse flag and two set of self reset N/C contracts with test push button shall be provided in the operating circuit of each control and relay panel to supervise the breaker control supply. One N/C contact shall be used for visual alarm and the other N/C contact shall be used for audible alarm and shall be connected to the alarm bus of the annunciation scheme.

A.D.C. operated no-voltage auxiliary relay provided with hand reset reserve flag indicator and two sets of self reset N/C contacts with test push button shall be provided in the main alarm bus to supervise the alarm but supply. One N/C contact shall be used for visual alarm and the other for audible alarm. The visual and audible alarm of alarm bus fail and those of incoming D.C. bus fail shall be common and shall be operated by 240 V single phase A.C. auxiliary supply as described in the Specification.

(** DC sources supervision relays are to be mounted in the panel)

2.12 A.C. CIRCUIT

240 volts, single phase, A.C. auxiliary supply to the control and relay board will be fed from A.C. distribution board through a suitable fuse switch provided thereof. A continuous A.C. bus shall be provided at the control and relay board where from A.C. supply to each panel shall be teed off through a set of links. One 16 Amp rated M.C.B. shall be provided at the control and relay board for the incoming A.C. supply. A set of fuse and link rated for 6 amps for 3 pin plug circuit, 6 amps for 2 pin ply circuit and 6 amps for heater and illuminating lamp circuits shall also be provided. A hand reset type no-volt auxiliary relay rated for 240 volts A.C. and provided for monitoring the auxiliary A.C. supply from D.C. operated facial annunciation scheme.

2.13 MCB's

The incoming DC supply sources (source I and source II)circuits in the control and relay panels shall be controlled by required Two pole DC MCB's. In each control and relay panel there shall be separate DC MCB as incoming to the panels and the sub circuits shall be controlled by HRC fuses of different circuits having both "+" ve and "-" ve control.The incoming MCB's also followed by HRC fuses for better protection. The ratings of the MCB's are to be designed to take care of the continuous rating and also during short ckt or in the event of faults. For AC incoming circuits and other distributed circuits circuits also to be provided with MCB of proper ratings.

2.14 MIMIC DIAGRAMS

10 mm. wide, 2mm thick colour mimic diagrams and symbols showing the exact representation of the system shall be provided in the front of control panel. The mimic strips shall be made with anodized aluminum materials, which shall be screwed on to the panel and can be easily cleaned. The colour code of such aluminium strips are as given in the following table. Upper bus and lower bus of the mimic shall represent the main bus and transfer bus of the station respectively. Central line of the upper bus mimic shall be at a distance of 695 mm from the top of the panel and center to center distance between the bus mimic shall be 610 mm.

When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of the mimic.

Indicating lamp , one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition.

TABLE

COLOUR SCHEME FOR MIMIC DIAGRAMS

Equipment	Colour	I.S. Code No.(IS.5)
400 KV	Orange	
220KV	Signal Red	537
132KV	Lemon Yellow	
33 KV	Brilliant Green	414
415/250V	Black	221

Earth	White	309
110 V	Canary Yellow	-

Automatic semaphore indicators shall be provided for isolators and earth switch position indication and incorporated in the mimic diagram

2.15 DISCREPANCY TYPE CONTROL SWITCHES.

Control switches for circuit breakers shall be incorporated in the mimic diagram to represent the relevant circuit breakers as also the sequence of the mimic diagram. The switches shall be provided with a built-in two lamp. The switches shall have maintained contact positions for 'ON' and 'OFF' positions respectively and two momentary contact positions for 'ON' and 'OFF' impulse.

2.15.1 The switches shall be provided with a notching mechanism which should accurately limit the angles of actuation. A strong restoring spring is to be provided to return the switch mechanism automatically from the momentary contact position to the maintained contact position. Such control springs shall be strong enough to prevent any inadvertent operation due to light touch or some other different arrangement should be provided to prevent any inadvertent operation. Such springs shall not be used as current carrying parts in these switches. The rating of the switch contacts shall be suitable for the duty imposed by the circuit breaker closing mechanism and shall conform to the recommendations to be given by the circuit breakers manufacturers. The built-in-pilot lamp of the control switch shall give a steady light when the position of the control switch corresponds to the position of the associated circuit breaker. A flickering light shall be given by the same lamp when due to hand operation or due to automatic tripping of the breaker, the position of the control switch does not coincide with that of the corresponding circuit breaker. The arrangement to provide the flickering voltage for the above purpose shall be made. In order to avoid continuous burning of the aforesaid built-in lamps associated with the control switches under steady state condition, the said lamps shall be connected through a switch. The circuit should be such that irrespective of the position of the aforesaid switch, winking of the lamp shall not be affected by change in respective control switch position. The winking of the control switch pilot lamp shall be followed by an alarm annunciation after a preset time adjustable between 0-10 secs. Switches complete with accessories for the above function shall be supplied.

2.16 INDICATING LAMPS

5/7 Watt Indicating cluster LED type Lamps shall be provided on the control panel mounting with rear terminal connections. Lamps shall be provided with series connected resister preferably built in the lamp assembly. Lamps shall have translucent lamp covers to difuse lights coloured red,green,amber,clear white or blue as specified as per the following:

	Function	Quantity	Colour of lens
1.	Circuit Breaker spring charged/normal pressure indication.	1 No.	Blue
2.	Circuit Breaker trip circuit healthy indication.	2 Nos.	White
3.	Circuit Breaker Low Air Pressure indication	1 No.(where necessary	White
4.	Incoming D.C. fail indication.	2 Nos.	White
5.	A. C. fail indication.	1 No.	White
6.	P. T. supply indication.	3 Nos.(where necessary)	Red/Yellow/ Blue.
7.	Indication lamps for CB closing ,opening Isolator closing and opening		Red and Green
8.	Auto trip	1 No.	Amber
9.	Protection on Transfer Mode	1 No.	White
10.	CB on Local/Remote	2 Nos	White

All the indicating lamps under (1) and (2) shall be provided with push button control. All the lamps shall be connected to the auxiliary D.C. supply of the sub-station except Sl.No 4 and Sl. No.6 which should be connected to the auxiliary A.C. supply and P.T. secondary supply. The lamps shall be suitable for switch board purpose and shall be of low watt consumption. Lamp and lenses shall be interchangeable and easily replaceable from the front of the panel.Tools if required for replacing the bulbs and lenses shall aalso be included in the scope of supply. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis. In initial supply, 20% of the lamps actually used on the switch boards and 10% of the lamp covers used shall be supplied in excess to serve as spares.

2.17 TEST BLOCKS

Switchboard type, back connected, test blocks with contacts shall be provided with links or other devices for shorting terminals of C.T. leads before interrupting testing instruments in the circuit without causing open circuit of the C.T. The potential testing studs shall preferably be housed in narrow recesses of the, block molding insulation to prevent accidental short-circuit across the studs. All Test Blocks for meters, relays, etc. shall be placed as close to the respective equipment as possible.

2.18 NAME PLATES & MARKING OF IDENTITY

All equipments,instruments, relays and such other similar electrical devices mounted on the front and rear side as well as mounted inside control and relay panels shall be provided with name plates bearing the manufacturer's name, serial number and the electrical rating data.

All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

Each equipment and meter shall be prominently marked with the quantity measured e.g. KV,A,MW,MVAR, etc. All relays and other devices shall be clearly marked with manufacturers name,type,sl No & electrical rating.

Name plates shall be made out of non-rusting metal or 3 ply lamicoid. Name plate shall be black with white engraving lettering.

Each switch shall bear clear inscription identifying its function e.g. "BREAKER" '52A','SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not otherwise identified. Switches also have clear inscription for each position indicating e.g. "TRIP-NEUTRAL-CLOSE","ON-OFF","R-Y-B-OFF" etc.

All panel shall be provided with name plate mounted inside the panel bearing LOA NO. & Date,Name of the sub-station & Feeder and reference drawing number.

2.19 SAFETY EARTHING FOR THE PANEL

All panels shall be equipped with an earth bus securely fixed.Location of earth bus shall ensure no radiation interference for earth system under various switching conditions of isolators and breakers. The materials and size of the bus shall be atleast 25X6 sq.mm perforated copper threaded holes at gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted aadjoining each other,the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

Provision shall be made on each bus bar of the end panels for connecting substation earth grid. Necessary clamps and connectors shall be included in the scope of contract.

All metallic case of the relays,instruments and other panel mounted equipment including gland plate shall be connected to the earth bus by copper wires of size not less than 2.5 sq mm.The colour code of earthing shall be green.

Looping of earth connections which would result in loss of earth connections to other devices when loop is broken shall not be permitted.However looping of earth connections between equipment to provide alternative path to earth bus shall be provided.

VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing the continuity of earthing syatem for other groups.

2.20 PANEL BOARD LIGHTING

The panel interior (both control panel and relay panel) shall be illuminated by 12W, LED tube light connected to 240 V. single phase A.C. The illumination of the interior shall be free from hand

shadows and shall be planned to avoid any strain or fatigue to the fireman likely to be caused due to subnormal or non-uniform illumination. One emergency D.C. light (LED type) shall also be provided for each relay panel with individual switch, with proper identification mark.

A door operated button switch shall be provided for control of the A.C. lighting for all the control and relay panel interiors.

One 5 amps. two pin socket and one 15 amps. 3 pin power socket outlets together with plugs shall be provided at convenient points in the panel board for A.C. supply.

2.21 ANNUNCIATOR

Each control and relay panel shall be provided with **microprocessor based** anunciator(s) facial on the front of the control panel for projecting mal-operation in the system equipment due to fault. The annunciation board shall be of the switch board type, back connected suitable for semi-flush mounting provided with dust tight cases. The single relays shall be suitable for tropical use. The alarm concealing visual signal resetting and annunciation testing buttons shall be mounted on the front of each control panel at convenient height, preferably under the annunciation board.

a) One part of the annunciation shall comprise of one electrical D.C. operated bell and one D.C. operated hooter for trip and non-trip alarm mounted inside or on top of the switch board cubicle on vibration absorbent mountings. A suitable hand reset relay device shall be employed in the suitable hand reset relay device shall be employed in the suitable alarm circuit to permit manual cancellation of the audible alarm in token of its acceptance by an operator before rectification of the abnormality. The wiring shall be such that a single set of bell and alarm cancellation relay will be sufficient and serve in commons with all the alarm actuating devices.

b) The other part of the anunciator shall discriminate and sort out the cause of alarm and project visual alarm signals by tokens of telephone type flush lamps illumined windows on facial plate. There shall be an independent token for each abnormal condition announced and the wiring of all the tokens shall be so done that each token will operate independently of the other without causing any maloperation on the enunciator. A reset device, manually operated by an operator, shall be provided for each column of the visual alarms to enable the operator to cancel each visual alarm at will after removal of the discrepancy or abnormal condition. Suitable testing device shall be provided on each enunciator to be assembled for routine checking of enunciator alarm and indication.
The enunciator shall be suitable for operation across the D.C. supply voltage of the sub-station.
Momentary closing of fault contacts shall also cause operation of enunciator system as above and shall require canceling and resetting operations by the operator to silence the bell and reset the enunciator window.

c) Minimum of 4 Nos spare windows each for trip and non trip are to be provided in each annunciator

2.22 INCOMING D.C. FAIL ALARM SCHEME

Control and Relay Board shall have a common “Incoming D.C. Fail” alarm scheme operated by 240 V single phase A.C. auxiliary supply for audible as well as visual alarm in case of failure of D.C. incoming supply to the board.
All auxiliary relays, test relays, canceling, resetting and testing push buttons, alarm bells etc. required to render the annunciation system operative as above shall be considered to be within the scope of the tender.
Separate scheme for each source of DC supply shall be considered.

2.23 INCOMING A.C FAIL ALARM SCHEME

Control and Relay Board shall have a common “Incoming A.C. Fail” alarm scheme operated by 240 V D.C. auxiliary supply for audible as well as visual alarm in case of failure of A.C. incoming supply to the board.

3.0 INDICATING INSTRUMENTS AND METERS

3.1 All electrical indicating instruments shall be of digital Type suitable for flush mounting

3.2 Instruments shall have 4- digit display, display height being not less than25 mm.

3.3 Instrument shall confirm to relevant IS and shall have an accuracy class of 1.0 or better. For energy meters it should be of minimum 0.2. watt and VAR meters shall have an indication of (+) and (-) to indicate EXPORT and INPORT respectively

3.4 Digital voltage and frequency meters shall be of class 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25 mm height.

3.5 All instrument shall be switchboard type, back connected suitable for flush mounting and provided with dust tight cases for tropical use with dull black enamel finish.

3.6 All fixing screws, nuts and treated parts shall be designed to Indian Standards.

3.7 All instruments shall have a practicable laboratory means of adjustment of accuracy. The limits of error shall be those permissible for industrial grade instruments of switch board type. The calibration of the instruments shall function satisfactorily when mounted on steel panels or alternatively magnetically shielded instruments shall be used.

3.8 Instruments shall be capable of indicating freely when operated continuously at any temperature from 0 to 50 deg. C.

3.9 All circuits of instruments shall be capable of withstanding the effect of shock vibration and humidity and a dielectric test of 2500 volts r.m.s to ground for one minute as per relevant BSS/ISS

4.0 NON-TARIFF ENERGY METERS (Not Required)

a) Export/Import KWH and KVARH meters for 33KV , 132 KV , 220 KV & 400 KV KV. Line shall be supplied by the Bidder. Necessary cut-out, wiring and 3 element Test Terminal Block are to be supplied by the bidder as specified in the Schedule of requirement of control panel. Export/Import meters for non-tariff use shall be of the commercial grade accuracy i.e 0.2 Class, and shall be of 3 element type and suitable for 3-phase, 3–wire connection.

b) One 3 element type KWH meter with M.D.I. for each 33 KV. 132 KV,220 KV. Transformer panel shall also be provided and shall be connected preferably on H.V. side.

c) One Trivector metre of solid state type with KWH, KVAH, KVARH with MDI is to be provided both for 33 KV. 132 KV,220 KV control panel.

4.1 MW INDICATOR

In all the 33KV, 132 KV,220,400 KV lines and transformer feeders, indicating MW meters with M.D.I. (three) element type shall be mounted on the front side of the control panels to indicate the instantaneous MW flowing. The MW meters shall be connected to the measuring C.T. core. Scale range for line feeders shall be 200-0-200 MW and for transformer feeders 0-150 MW or as suitable for the proposed system.

4.2 MVAR INDICATOR

In all the 400 KV,220KV. 132 KV line feeders indicating MVAR meters shall be mounted on the front side of the control panel to indicate the instaneous MVAR following through the feeder in either direction. The scale should be center zero. The MVAR meters shall be connected to the measuring C.T. core. The scale shall be 200-0-200 MVAR or as suitable for the proposed system

5.0 Relays

A. General

The Numerical Relays in general shall comply with the following requirements:

1. All relays shall conform to the requirements of IS: 3231/IEC60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semiflush mounting on the front with connections from the rear.

2. **The offered relays shall be completely numerical.**

- The communication protocol shall be as per IEC 61850 & IEC60870-5-103
- The test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.
- Protection elements should be realised using software algorithm.
- Hardware based measurement shall not be acceptable.

3 The relay shall be provided with both 1A and 5A CT inputs and shall be selectable at site.

4. It shall be possible to energise the relay from either AC or DC auxiliary supply.

5. The offered relay shall have a comprehensive local MMI for interface. It shall have the following minimum elements so that the features of the relay can be accessed and setting changes can be done locally.

- At least 48 character alphanumeric backlit LCD display unit Fixed LEDs (for trip, Alarm, Relay available & Relay out of service) & programmable LEDs which can be assigned to Tactile keypad for browsing and setting the relay menuany protection function for local

annunciation.

6. The minimum pickup voltage of relay for 220 V DC systems must be 176 V for binary imput in order to prevent pick up during DC earth fault condition.

7. The relays supplied should be compatible to redundant communication architecture, shall be complied with the IEC 62439-3 standards of parallel redundancy protocol (PRP).

8. The relays provided should be complied with the international standards of NERC CIP for cyber security to provide protection against unauthorized disclosure, transfer, modification, or destruction of information and/or information systems, whether accidental or intentional.

9. All PCB used in relays should have harsh environmental coating as per standard IEC 60068 (HEC) to increase the particle repellency and thereby increasing the life of relay.

10. The offered relays shall be completely numerical and **should comply to IEC 61850 protocol. The relay** must support following requirements for communication ports and protocols,

- The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking and also to ensure interoperability with third party relays.
- The relay must have front RS232/USB/RJ45 port for local communication with the device
- The communication protocol shall be as per IEC 61850
- The relay should be compatible to redundant communication architecture and shall be complied with IEC 62439-3 standards of parallel redundancy protocol (PRP)
- The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking and also to ensure interoperability with third party relays.
- Necessary user friendly configuration tool shall be provided to configure the relays. It should be compatible with SCL/SCD files generated by a third party system.
- GOOSE signals shall be freely configurable for any kind of signals using graphic tool/user friendly software.
- The offered relay must support at least 4 no's of 61850 clients
- The relay must support time synchronization through SNTP/IRIG B demodulated.
- The relays provided should be complied with the international standards of NERC CIP for cyber security to provide protection against unauthorized disclosure, transfer, modification, or destruction of information and/or information systems, whether accidental or intentional.
- The relay settings shall be provided with adequate password protection. The password of the relay should be of 4 character upper case text to provide security to setting parameter.

11. The relays shall have the following tools for fault diagnostics

- Fault record – The relay shall have the facility to store at least 5 last fault records with information on cause of trip, date, time, trip values of electrical parameters.
- Event record – The relay shall have the facility to store at least 200 time stamped event records with 1ms resolution.
- Disturbance records – The relay shall have capacity to store the waveforms for a minimum duration of at least 5 secs with settable pre and post fault duration times at a minimum sampling rate of 800 Hz or Higher.
- Except for differential protection the disturbance recorder must have capability to capture at least 8 analogue channels (IA, IB, IC, IN, VA, VB, VC, and VN) and 15 digital channels (start of protection element, trip of protection element, binary input, trip output etc) selectable at site.
- For differential protection relay, the disturbance recorder must have capability to capture at least 15 analogue channels and 30 digital channels.
- Necessary software shall be provided for retrieving and analyzing the records.

12. The relay settings shall be provided with adequate password protection. The password of the relay should be of 4 character upper case text to provide security to setting parameter

13. The relay shall have comprehensive self-diagnostic feature. This feature shall continuously monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated through a output watchdog contact. The fault diagnosis information shall be displayed on the LCD and also through the communication port.
14. The Numerical Relays shall be provided with 1 Set of common support software compatible with both Windows 7 and higher which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, measurements.

- The relay settings shall also be changed from local or remote using the same software.
- Additional functions can be added to relay by software upgradation and downloading this upgraded software to the relays by simple communication through PC.

15. All protective relays shall be in draw out or plugin type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.
16. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.
17. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification .Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.
18. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

a. No control relay, which shall trip the power circuit breaker when the relay is deenergised, shall be employed in the circuits.
b. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
c. Auxiliary sealinunits provided on the protective relays shall preferably be of shunt reinforcement type.
d. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

19. Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the OPTCL
20. The relay must be able to continuously measure following parameters with a typical accuracy of ± 1%.

- Current (0.05 to 3 In) +/- 1.5% of reading,
- Voltage (0.05 to 2 Vn) +/- 1.0% of reading
- Frequency (40 to 70 Hz) +/- 0.03 Hz
- Phase 0° to 360° +/- 5.0%
- Power (W) +/- 5.0% of reading at unity power factor
- Reactive power (VARS) +/- 5.0% of reading at zero power factor
- Apparent power (VA) +/- 5.0% of reading

6.0 Protection System

Protective system

6.1 Protection discrimination

On the occurrence of a fault on the power system network the high speed discriminating protection systems (main protection) shall rapidly detect the fault and initiate the opening of only those circuit breakers which are necessary to disconnect the faulted electrical element from the network. Protection equipment associated with adjacent electrical elements may detect the fault, but must be able to discriminate between an external fault and a fault on the electrical element which it is designed to protect. Sequential time delayed tripping is not permitted except in the following specific circumstances:

- Protection for short connections between post current transformer housings and circuit breakers when the technical advantages of complete overlapping of the protection are outweighed by economic considerations, (i.e. short-zone protection)
- Operation of time graded back-up protection takes place as a result of either the complete failure of the communication links associated with the main protection systems, or the fault resistance is substantially greater than a value which can be detected by main protection systems.
- Operation of line back-up protection to disconnect primary system faults in the case of a circuit breaker failing to operate, (i.e. circuit breaker failure protection)
- All back-up protection systems shall be able to discriminate with main protection systems, circuit breaker fail protection and with other back-up protection systems installed elsewhere on the transmission system.

6.2 Protection settings

A list of the settings to be applied to all protection systems together with all associated calculations, shall be provided for review and approval not less than three months prior to the first programmed date for commissioning. The settings for line protection shall be such as to permit correct operation of the protection for earth faults with up to 100 ohms fault resistance. Any limitations imposed on the power system as a result of the settings proposed shall be explicitly stated. In the absence of system data required for calculation purposes, assumptions may be made providing these are clearly identified as such in the relevant calculations.

6.3 Fault clearing time

The protection equipment shall be capable of achieving the following discriminative fault clearing times, inclusive of circuit breaker and signalling times:

- One millisecond for all electrical elements whose boundary connections are defined by circuit breakers located within a given substation.
- For interconnecting tie lines in which the boundary connections of the electrical element being protected are defined by circuit breakers located in adjacent switching stations, an additional 20 ms fault clearance time is allowed at the substation remote from the fault point. This additional fault clearance time is permitted subject to the requirement that the positive sequence impedance of the primary circuit from the switching terminal to the point of fault shall not be less than ten ohms.

The Contractor shall supply the Project Manager with details of the operating times under defined conditions of all protection equipment proposed. Any limitation in operating time performance shall be declared by the Contractor, e.g. end of zone faults where distance protection is applied, high resistance faults, faults at high X/R with significant DC component and time constant, faults coincident with communication channel noise. The Contractor shall specify the increase in operating time which could occur under such conditions.

6.4 Signalling equipment operating times:

For design purposes the operating times of signalling equipment to provide a contact signal for use with associated distance protection shall be assumed to be as follows:

- Intertripping (transfer trip) not greater than: 20 milliseconds
- Permissive transfer trip: 15 to 20 milliseconds
- Blocking signal operate time: 10 milliseconds
- Blocking signal reset time: 10 milliseconds

Protection Schemes

6.5 Line protection

General requirement for line protection relays

The line protection relays shall protect the line and clear faults on line in the shortest possible time with reliability, selectivity and full sensitivity to all types of line fault. The general concept for

1) 400kV and 220kV levels is to have primary and back-up protection systems having equal performance requirement especially in respect of time as would be provided by two Main protections called **Main-I** and **Main-II.** It is desirable that Main-I and Main-II protection should work on two different principles of operation and one back up dir O/C & E/F protn is envisaged.
2) For 132 kV level the concept of one main distance protection and one backup directional O/C and E/F protection is envisaged.
3) For 33 kV level, the requirement is that of modular directional O/C and E/F protection.

The protection requirements are summarised below, and illustrated in the single line diagrams in the schedules.

- **400kV and 220kV lines**
  - Main I Numerical non switched distance protection meeting performance levels.
  - Main II Numerical non switched phase comparison, carrier aided or of numerical distance using a different principle of operation
  - Phase segregated teleprotection facility
  - Power swing detection blocking and tripping
  - Synchronising.
  - Line overvoltage (Only for 400kV and 220kV line □ 200kM long)
  - Autoreclosure
  - Numerical directional overcurrent and earth fault
  - Three phase to ground
  - Numerical local breaker back up
  - Pole discrepancy protection

6.5.1 Distance Protection Relay

a. The IEC 60255-121 standard "Functional requirements for distance protection" published in March 2014, specifies the minimum requirements for functional and performance evaluation of distance protection relays, describes the tests to be performed and how to publish the test results. The relay should conform to above standard.

b. The protection should be be fully numerical and be based on a non-switched scheme.

c. Provide protection for the transmission line from all types of faults-phase to earth faults as well as multiphase faults. The protection algorithm shall have dual redundant distance protection algorithms to detect all types of power system faults so as to arrive at a secure trip decision with correct phase selection and proper direction discrimination in the shortest possible time.

d. The protection should have non-switched measurement, which implies processing of six possible fault loops (six –loop measurement)

e. It should have polygonal characteristics with independently adjustable reactive and resistive reaches for maximum selectivity and maximum fault resistance coverage. The zones shall have independent settable earth fault compensation factors to cater to adjacent lines with different zero sequence to positive sequence ratios

f. Selection shall be so that the first zone of the relay can be set to about 80% - 85% of the protected line without any risk of non-selective tripping.

g. The second and third zone elements shall provide back up protection in the event of the carrier protection or the first zone element failing to clear the fault, zone-2 shall cover full protected section plus 50 % of the next section, zone-3 shall normally cover the two adjacent sections completely.

h. It must have load encroachment features and must support blocking of the selected zones during heavy load condition.

i. It should have adequate number of forward zones (minimum three) and a reverse zone. The zone reach setting ranges shall be sufficient to cover line lengths appropriate to each zone. Carrier aided scheme options such as permissive under reach, over reach, & blocking and non-carrier aided schemes of zone 1 extension and Loss of load accelerated tripping schemes shall be available as standard. Weak in feed logic and current reversal guard also shall be provided.

j. In case the carrier channel fails, one out of the non-carrier based schemes cited above should come into operation automatically to ensure high speed and simultaneous opening of breakers at both ends of the line.

k. In addition to the conventional impedance measuring algorithm the distance protection relay should have a separate measuring technique in the same hardware completely different to the conventional impedance measuring principal. Both the algorithms should run in parallel and should take trip decisions independently.

l. Have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) with CVT being used on the line :

- For SIR 0.01-4 : as 40ms at the nearest end and 60ms at the other end of line
- For SIR 4-15 : as 45ms at the nearest end and 65ms at the other end of line
- With carrier transmission time taken as 20ms.

m. Have a secure directional response under all conditions, achieved by memory voltage polarizing and/or healthy phase voltage polarizing as appropriate.

n. Shall have an independent Directional Earth Fault (DEF) protection element to detect highly resistive faults. This element shall have an inverse time/definite time characteristic with a possibility to configure the DEF as a channel-aided DEF or a channel-independent DEF

o. Have logic to detect loss of single/two phase voltage input as well as three phase voltage loss during energisation and normal load conditions. The voltage circuit monitoring logic should in addition to blocking the distance protection element, enable an emergency overcurrent element to provide a standby protection to the feeder till the re-appearance of voltage signal.

- The VT fuse failure function shall function properly irrespective of the loading on the line. In other words the function shall not be inhibited during operation of line under very low load conditions.

p. Have necessary logic to take care of switch-on-to-fault condition. Energisation of transformers at remote line ends and the accompanying inrush current shall not cause any instability to the operation of relay.

q. The line protection IED should have power swing blocking feature, with facilities for :

i. fast detection of power swing
ii. selective blocking of zones
iii. settable unblocking criteria for earth faults, phase faults and three phase faults.

r. Also the Distance protection IED should have following features in built in it.

- suitable for single pole or three pole tripping.
- Shall have inbuilt CT supervision facility. A time-delayed alarm shall be issued if a CT open circuit is detected.
- Shall have inbuilt **Trip circuit supervision** facility to monitor both pre- and post close supervision facilities. An alarm shall be generated.

Shall have inbuilt **Circuit Breaker Failure protection** based on undercurrent detection and/or circuit breaker auxiliary contact status and/or distance protection reset status. Provision shall be given to initiate the breaker fail logic using a digital input from external protection devices.

- Shall have inbuilt in **broken conductor detection** by measuring the ratio of I 2 & I1 . The sensitivity of the logic shall not be affected during operation under low load.

- Shall have a **fault locator** with an accuracy of ±3%. The display shall be in kilometers, miles or percentage impedance . The fault locator should have built in mutual compensation for parallel circuit.

s. Be capable of performing basic instrumentation functions and display various instantaneous parameters like Voltage, current, active power, reactive power etc. in primary values. Additionally all sequence current and voltage values shall be displayed on-line. Also the direction of power flow shall be displayed.

t. The relay shall have a built-in **auto-reclose** function with facilities for single pole / three pole / single and three pole tripping. It shall be possible to trigger the A/R function from an external protection. A voltage check function which can be programmed for dead line charging/dead bus charging / check synchronising shall be included.

u. Records containing discrete data on the last five faults shall be made available. In particular the fault resistance value shall be available for each record.

v. Facility for developing customized logic schemes inside the relay based on Boolean logic gates and timers should be available. Facility for renaming the menu texts as required by operating staff at site should be provided.

w. The protection relay should have the following additional elements

i. Under / Over voltage protection. The relay shall have two stages of voltage protections where each stage can be set as under/over voltage. The drop off/Pickup ratio can be set up to 99.5%.

ii. The relay shall have built in Circuit Breaker Supervision Functions for Condition based Circuit Breaker Maintenance

iii. The relay shall be able to detect any discrepancy found between NO & NC contacts of breaker
iv. The relay shall monitor number of breaker trip operations
v. The relay shall record the sum of the broken current quantity
vi. The relay shall also monitor the breaker operating time
vii. In all the above cases the relay shall generate an alarm if the value crosses the threshold value.

6.5.2 NUMERICAL TRANSFORMER DIFFERENTIAL RELAY

a. General requirements for transformer protection scheme : The differential protection IED

- The offered relay must be suitable providing complete protection for 2 winding transformer, 3 winding transformer and auto transformer
- **Category-A:** For 3 winding differential Protection, it must have 12 CT input, 3 for phase CT HV side, 3 for phase CT LV side, 3 for Phase CT TV side,1 for neutral CT HV, 1 for neutral CT LV, 1 for neutral CT TV.
- **Category-B:** For 2 winding differential protection, it must have 8 CT input, 3 for phase CT HV side, 3 for phase CT LV side, 1 Neutral CT HV side, 1 Neutral CT LV side.
-

- The relay must be suitable for providing low impedance REF protection for auto transformer.
- For 2 Winding transformer, 1 VT input and for 3 winding transformer 4 VT input are required.
- The protection function requirement for Transformer protection relays are as mentioned below,
- Differential protection (Low Impedance type with 3 slope characteristic)
- 2 elements of REF Protection for 2 winding transformer and must be selectable between Low Impedance and High impedance REF as per the site requirement's
- 3 elements of REF protection for 3 winding transformer and must be selectable between Low and High impedance REF
- REF protection for autotransformers.
- Backup Over current and Earth fault for each winding
- Thermal overload protection
- Over excitation protection
- Over and Under frequency protection
- CB Fail protection for each Winding (CT) input
- Shall be stable during magnetizing inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents. The second harmonic blocking threshold shall be programmable one.
- Shall have facility to deactivate harmonic restraint and over fluxing restraint functions.
- Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
- The relay should be capable of detecting the CT saturation. Relay should use appropriate algorithm to detect light saturation condition.
- It shall be possible in the relay to individually set MVA rating of transformer per winding.
- Relay should have vector group and magnitude correction. Relay should have facility for filtering zero seq. current for stability of X-mer differential protection (87T) during through fault.
- Thermal overload protection as per IEC 60255.
- The relay shall have through fault monitoring element to monitor the HV, the LV or the TV winding to give the fault current level, the duration of the faulty condition, the date & time for each through fault.
- The relay shall have REF protection, be selectable separately for each winding and programmable as either high or low impedance. The REF function should be able to share CT's with the biased differential function. The REF protection provided should be suitable for auto transformer also.
- Shall have all output relays suitable for both signals and trip duties.
- Shall be stable during magnetizing inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents. The second harmonic blocking threshold shall be programmable one.
- Shall have facility to deactivate harmonic restraint and over fluxing restraint functions.
- Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
- Shall have software for interposing current transformers for angle and ratio correction to take care of the angle & ratio correction.
- Shall have all output relays suitable for both signals and trip duties.
- Shall have transient bias to enhance the stability of differential element during external fault condition.
- The relay should have combined harmonic blocking and restraint features to provide maximum security during transformer magnetizing inrush conditions

b. Functional Description.

i. Differential Protection

- The relay shall be biased differential protection with triple slope tripping characteristics with faulty phase identification / indication . The range for the differential pick-up shall be from 0.1 to 2.5 pu. Its operating time shall not exceed 30 ms at 5 times rated current.
- The relay shall have adjustable bias slopes m1 from 0 % to 150 % and slope m2 from 15% to 150 % so as to provide maximum sensitivity for internal faults with high stability for through faults.
- The relay shall have an unrestrained highset element to back up the biased differential function and the setting range for it shall have a minimum setting of 5pu and a maximum setting of 30pu.
- The relay shall have the stability under inrush conditions . The ratio of the second harmonic component to the fundamental wave for the differential currents of the measuring system shall serve as the criterion.
- The device shall have reliable detection technique, preferably no gap detection technique to ensure stability during inrush. Any type of time delay is not acceptable to differentiate inrush and fault condition.
- The relay shall provide restraint for over fluxing condition for the transformer by measuring the ratio of the fifth harmonic to the fundamental for the differential current if subjected to transient over fluxing. The fifth harmonic blocking feature should have variable percentage setting.

ii. Restricted Earthfault Protection (64 R)

This function should be provided to maximise the sensitivity of the protection of earthfaults. The REF function should be selected seperately for each winding and programmable as either high or low impedance. The REF function should be able to share CT's with the biased differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents. The REF protection provided should be suitable for auto transformer also.

iii. Overfluxing Protection (99 GT)

The relay shall Over fluxing protection Volts/Hertz protection to the transformers protected. By pairs of v/f and t , it shall be possible to plot the overfluxing characteristics in the relay so that accurate adaptation of the power transformer Over fluxing characterisitics is ensured.

In addition the relay should have a definite time element for alarm. The reset ratio for Overfluxing Protection shall be 98%.

iv. Overload Protection.

Shall have thermal overload protection for alarm and trip condition with continuously adjustable setting range of 10-400% of rated current

v. Overcurrent Protection (50,51)

The relay shall have three stages of definite time overcurrent protection as backup operating with separate measuring systems for the evaluation of the three phase currents ,the negative sequence current and the residual current.

In addition the relay shall have three stages of Inverse time overcurrent protection operating on the basis of one measuring system each for the three phase currents ,the negative sequence current and the residual current.

vi. Over / Under frequency

The relay shall have four stages of frequency protections where eah stage can be set as under/over frequence, under/over frequence with df/dt

vii. Over / Under Voltage

The relay shall have two stages of voltage protections where each stage can be set as under/over voltage. The adjustable drop off/Pickup ratio better than 97% should be available.

viii. Local Breaker Back up protection:

The relay shall in built LBB protection to detect the failure in the local breaker using the undercurrent criteria and trip the upstream breaker.

6.5.3: FEEDER MANAGEMENT RELAY

Protection and Control function requirements for feeder Management Relay.

- The Relay provides the following current based protection functions:
- Phase/Neutral/Ground instantaneous overcurrent
  - Phase/neutral/ground time overcurrent
  - Negative sequence Timed overcurrent
  - Phase/neutral directional overcurrent
  - Restricted Ground Fault (87REF)
  - Breaker Failure (50BF)
  - Thermal Model (49)
  - Cold Load Pickup (CLP)
- The Relay provides the following voltage based functions:
  - Phase Over and Under Voltage
  - Neutral Over Voltage
  - Directional Power
  - Forward Power
- The Relay provides the following control functions:
  - 4 Shot Auto Reclose (79)
  - VT Fuse failure (VTFF)
  - Over/Under Frequency (81O/81U)
  - Rate of change of Frequency (81df/dt)
  - Synchrocheck (25)
  - Breaker Failure (50BF)
- At least 5 user configurable commands for local and remote (Remote through SCADA on MMS)
- Configurable one line diagram for the substation bay
- The relay should have 2 switchable setting groups for dynamic reconfiguration of the protection elements due to changed conditions
- Programmable LOGIC
- Relay supports user defined logic to build control schemes supporting logic gates, timers, nonvolatile latches.
- The Relay configuration tool has an embedded graphical user interface to build programmable logic.

FRONT-PANEL VISUALIZATION

- The front panel includes user-programmable LEDs and pushbuttons and navigation keys.
- For bay information that includes user programmable screens for:
  - One line diagram displaying
  - Switchgear operation
  - Access to metering information
  - Alarm panel display.
  - I/O status display.
  - Relay settings

6.5.4: BACKUP RELAYS (Current Protection).

The combined overcurrent and earth-fault relay is connected to the current transformers of the object to be protected. The overcurrent unit and the earth-fault unit continuously measure the phase currents and the neutral current of the object. On detection of a fault, the relay will start, trip the circuit breaker, provide alarms, record fault data, etc., in accordance with the application and the configured relay functions.

FUNCTIONAL DESCRIPTION;

Three-Phase Overcurrent (50/51) & Earth Overcurrent (50N/51N)

Three independent stages are available either for phase and earth fault protection. For the first and second stage the user may independently select definite time delay (DTOC) or inverse time delay (IDMT) with different type of curves (IEC, IEEE/ANSI, IS 3231:1987).

Three-Phase & Earth-Fault Directional Overcurrent (67/67N)

Each of the three-phase overcurrent stages & earth fault stages can be independently configured as directional protection and with specific characteristic angle (RCA) and boundaries as per IEC, IEEE/ANSI,IS . The phase fault directional elements should be internally polarised by quadrature phase to phase voltages. A synchronous polarising function or any other suitable algorithm may be provided to ensure a correct operation of the overcurrent elements for close-up three phase faults where the collapse of the polarising line voltages occurs.

Under / Over Voltage (27/59)

Independent under-voltage stage and two or more over-voltage stages may be provided. They should be definite time elements. Each stage can be configured to operate from either phase-neutral or phase-phase voltages. The drop off to pick up ratio should be 99.5%.

Under / Over Frequency (81U/O)

Time delayed under and over frequency protection on the fundamental form of frequency protection is to be provided When the frequency measured is crossed 6 pre-defined thresholds, the relays should generate a start signal and after a user settable time delay, a trip signal.

Circuit Breaker Failure Protection (50BF)

The circuit breaker failure verifies the effective opening of the CB by a dedicated undercurrent threshold. The circuit breaker failure function can be activated by trip of a generic protection or/and external command by the relevant digital input. The circuit breaker failure protection can be used for tripping upstream circuit breakers too.

6.5.5: For numerical relays, the scope shall include the following:

1. Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.
2. The relay shall have suitable communication facility for connectivity to SCADA.
3. IED should be IEC 61850 compliant.
4. IED should support PRP (Parallel Redundancy Protocol)
5. In case of line protection and transformer/reactor protection, the features like fault recorder and event logging function as available including available as optional feature in these relays shall be supplied and activated at no extra cost to the owner. Also necessary software/ hardware for automatic uploading to station HMI/DR work station (as applicable) shall be supplied.

6.5.6. Technical Particulars of IED

1. **Standards and regulations**:

IEEE/IEC/ANSI/CE/IS	IS: 3231/IEC60255/IEC 61000

2. Analogue Inputs and Outputs

Nominal Frequency fN	50 Hz
Nominal Current	1A/5A
Power Consumption	0.05VAat IN=1A, 0.3VAat IN=5A
Current Overload Capability per Current	100* IN for 1Sec.

Input thermal (rms)	30*IN for 10Sec 4*IN continuous
Dynamic (pulse Current)	1250A (half cycle)
Nominal Voltage Ph-Ph rms (VN)	110V
Operating range Ph-Ph rms	0-200V
Continuous	2*VN
10 seconds	2.6*VN

3. Auxiliary voltage

Nominal Range	Operative Range
220V dc	180-300Vdc
Power Consumption dc	< 50W
Ripple superimposed AC Voltage	≤ 15% auxiliary nominal voltage.
230VAC	90-270VAC
Power Input AC	< 30VA

4. Input / output modules

Binary inputs	
a) number of input	a) Minimum 6 Nos for Backup relays. b) Minimum16 Nos for feeder management relays c) Minimum 12/04 Nos for Transformer Differential Relays. **(Category-A/B)** d) Minimum 24/12 Nos for Distance Protection Relays(**Category-A/B**)
b) voltage range	240V ±20%
c) power consumption	< 0.4W
Output contacts	
1. number of output contact	a) Minimum 8 Nos for Backup relays. b) Minimum 12 Nos for feeder management relays c) Minimum 12/08 Nos for Transformer Differential Relays. **(Category-A/B)** d) Minimum 32/16 Nos for Distance Protection Relays**(Category-A/B)**
2. Nominal Voltage	240V DC ±20
3. permissible current	Make & carry 30A for 0.2sec. ANSI C37.90
	Continuous; 5A IEEE C37.90

5. **LED**

LED displays:	
Status LED	17.2. Relay Healthy
	17.3. Relay Start
	17.4. Relay Trip
Alarm Indication	Configurable LED for indication. Minimum 8Nos for Backup relays. Minimum 8 Nos for feeder management relays Minimum 8 Nos for Transformer Differential Relays. Minimum 14Nos for Distance Protection Relays.

6. **Protection Function**

DISTANCE PROTECTION RELAY :

21P	Distance protection 21
21G	Distance protection zones (PDIS)
25	Synchocheck
27/59	Under/Over Voltage (2 stage over voltages)
46	Negative Phase Sequence
46BC	Broken Conductor
50/51,50N/51N	Instantaneous/Time overcurrent.
50BF	Breaker failure
67/67N	Direction Over current
79	Auto Reclose
81	Frequency Function.
FL	Fault Locator
DR	Disturbance Recorder
EL	Event Log.
MES.	Measurement.
CTS	CT Supervision
VTS	VT Supervision
TCS	Trip Ckt Super vision
TRANSFORMER DIFFERENTIAL RELAY	
24	Over-excitation.
27/59	Under/Over Voltage
49	Thermal Overload
46	Negative Phase Sequence
50/51,50N/51N	Instantaneous/Time overcurrent.
50BF	Breaker failure
87G	Restricted Earthfault.
~~67/67N~~	~~Direction Over current~~
87	Differential Protection.
81	Frequency Function.
FL	Fault Locator
DR	Disturbance Recorder
EL	Event Log.
MES.	Measurement.
CTS	CT Supervision
VTS	VT Supervision
TCS	Trip Ckt Super vision
BACK UP RELAYS(CURRENT PROTECTION)	
50	Instantaneous phase overcurrent protection
51/67	Four step phase overcurrent protection
50N	Instantaneous residual overcurrent protection
51N/67N	Four step residual overcurrent protection
50BF	Breaker failure protection (RBR
81	Under frequency
FEEDER MANGEMENT RELAY	
50	Instantaneous phase overcurrent protection
51/67	Four step phase overcurrent protection
50N	Instantaneous residual overcurrent protection
51N/67N	Four step residual overcurrent protection
27 /59	Under Over Voltage
50BF	Breaker failure protection
81U	Under frequency
81R	df/dt
25	Check synchronise
32	Power Protection
79	Multi shot Auto Recloser
Control	Switchgear Control Capability.

7. Secondary Supervision & Communication

Secondary system supervision	
	Current circuit supervision Fuse failure supervision
Monitoring	
	Measurements Event counter Disturbance report Fault locator
Communication	
	IEC61850-8-1 Communication IEC60870-5-103 communication protocol Single command, 16 signals Multiple command and transmit. PRP compliant.
a)Synchronization facility with GPS Cloak b)Front port communication c)Rear port d)Optional port	a) IRIG-B/ SNTP b) RS 232/Ethernet/USB c) FO and RJ45 port for IEC 61850-8-1 d) RS232/485
Process Bus Interface IEC 61850-9-2LE	
	If asked.

8. **Mechanical design**

1. type of mounting	Rack or panel mounting
2. degree of protection	IP52 & above
iii. permissible mechanical stress during operation b. permissible mechanical stress during transport Impedance starter	•Vibration IEC 60255-21-1:1996 Response Class 2 Endurance Class 2 •Shock and bump IEC 60255-21-2:1995 Shock response Class 2 Shock withstand Class 1 •Seismic IEC 60255-21-3:1995 Class 2

9. **Insulation test:**

	As per IEC 60255-5:1977
a) high voltage test on all circuits except auxiliary voltage	2KV for 1 min
b) high voltage test on voltage circuit only	2KV for 1 min
c) impulse voltage test on all circuits	5KV peak,1.2/50 micro s ,0.5

10. **Noise immunity test**

1.	

2. high frequency	IEC 60255-22-1:1988 Class III At 1MHz,for 2s with 200 Source Impedance: 2.5kV peak between independent circuits and independent circuits and case earth. 1.0kV peak across terminals of the same circuit.
3. electrostatic discharge	Electrostatic discharge IEC 60255-22-2:1996 Class 4 15kV discharge in air to user interface, display and exposed metal work. IEC 60255-22-2:1996 Class 3 8kV discharge in air to all communication ports.6kV point contact discharge to any part of the front of the product.
4. radio frequency electromagnetic field, non modulated	C37.90.2:1995 25MHz to 1000MHz,zero and 100%square wave modulated. Field strength of 35V/m.
5. radio frequency electromagnetic field, amplitude modulated	
6. power frequency magnetic field	
7. radio frequency electromagnetic field, pulse modulated	
8. fast transient	IEC 60255-22-4 :1992 Class IV 4kV,2.5kHz applied directly to auxiliary supply 4kV,2.5kHz applied to all inputs.
9. conducted disturbance induced by radio frequency field, amplitude modulated	IEC 61000-4-6:1996 Level 3 10V,150kHz to 80MHz at 1kHz 80%am
Interference emission test a. radio interference voltage b. radio interference field strength	89/336/EEC EN50081-2:1994 EN50082-2:1995

11. Climate stress test

1. permissible ambient temperature during operation	–25 °C to +55 °C
2. permissible ambient temperature during storage	–25 °C to +55 °C
3. permissible ambient temperature during transport	–25 °C to +70 °C
4. permissible humidity	56 days at 93%RH and +40 °C

ELECTROMECHANICAL AUXILIARY RELAYS:-

Relays shall be suitable for semi flush mounting on the panel board. All the relays shall be back connected, protected with dust tight cases for tropical use and finished with dull black enamel paint. The adjusting devices, shall be accessible with the relay mounted on the panel board. Flag type operating indicators and flag indicator reset devices shall be provided. The latter shall be suitable for operation from the front of the relay case, without opening the cover. The relays shall comply in all respects with the requirements of IS: 3231 (latest edition) or equivalent standards and shall be suitable for operation under the climatic condition specified. The relays shall be suitable for operation within a temperature range of 0 deg. to50 deg. C. The current coils shall be rated for a continuous current of 1 ampere and the voltage coils for 110 V normal. The contacts of the relays shall be silvered and precautions shall be taken to prevent or minimize damage due to arc which have to be successfully broken against 240 V D.C. When open, the contacts shall withstand a voltage of 115% of the normal circuit voltage. The relays shall preferably be provided with suitable seal-in-devices.

OTHER PARTICULARS OF AUXILIARY RELAYS:-

1. The auxiliary relays shall be, designed for continuous operation at 250 V. D.C. and shall withstand 110% rated voltage continuously. This shall also be suitable for satisfactory operation at 85% rated Voltage.

2. All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription subject to Purchaser's approval. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similar separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as buchholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

3. Self reset auxiliary voltage relays rated for specified D.C voltage shall be provided for use in the interlocking schemes for multiplication of contacts suiting contact duties of protective relays and for monitoring of control supplies and circuits. Monitoring relays for lockout relay circuits shall be connected in series with lockout relays coils. The Bidder shall be responsible to ensure that the monitoring relay ratings are such that they shall positively pick-up through the breaker coils / lockout relays coils monitored, but the breakers / lockout relays shall not operate with such a connection.

d) The supply and circuit monitoring relay shall be connected to initiate an alarm upto failure of respective supply / circuit . They shall preferably have reverse flags, which drop when relay is de-energised. Otherwise, an indicating lamp shall be provided with each monitoring relay for indication of its operation.

e) Close positions relays of main supply circuit beakers initiating automatic closure of stand by supply breakers shall have adequate time delay on drop out so that complete closure of stand by supply breaker is ensured . This feature will be used for obtaining limitation of duration of impulse for automatic closure of stand by supply breakers. In case the close position relays with such time delay are not available, additional slugged D.C auxiliary with adequate time delay on drop out may be supplied for automatic reverse closure . The exact arrangement will depend on the actual control schemes and shall be subject to the approval of purchaser.

6. The lockout trip relays shall be multi contact, hand reset type . The latching mechanism shall be positive and insensitive to vibration and shock. The reset devices on the front of the relay panel shall not permit manual tripping . Each lock-out relay shall be furnished with a panel mounted isolating arrangement to permit opening of trip circuits for testing .

1. AUX. Relay Type- (ALARM ANNUNCIATION), 250 V DC

Case Size-**3 element**
20 Terminal
Flag -Required
Mounting -Flush
Aux. Contacts-4 N/O

THREE POLE VOLTAGE OPERATED AUXILIARY RELAY.
Technical specification

Relay type

Aux.current or voltage	220 - 230V dc
Contacts - unit L.H	3 N/O 1 N/C H/R
Contacts - unit CTR	3 N/O 1 N/C H/R
Contacts - unit R.H	3 N/O 1 N/C H/R
Flag	Yes
Mounting	Flush

COIL RATING
D.C.75%-120% of rated voltage
AC.80%-115% of rated voltage
Operating voltage- not greater than 70% of voltage rating.
Operating time-15-20ms typical minimum at nominal voltage.
Burden-
2watts for 30,125v
6watts for 50,250v.
Operation indicator
Hand reset operation indicator provided

1. RESTRICTED EARTH FAULT RELAY (ATTRACTED TYPE ELECTRO- MECHANICAL):

TYPE: Electro-mechanical

The REF relay (attracted armature type) to be used along with a stabilising resistor & Metrosil, which is designed for applications where sensitive settings with stability on heavy through faults are required. It is recommended for balanced and restricted earth fault, bus-zone and certain forms of differential protection for auto-transformers, Power Transformers etc. The relay shall operate as a high impedance unit protection scheme & to be connected in the system accordingly. The relay shall be attracted armature unit of simple and robust construction.
The operating coil shall be provided with the accessories like series resonant circuit. Current tapping should be provided for different current setting by making suitable arrangement. The construction of the relay should be simple & electromechanical construction, detection element, and the output contacts should be in the same device, which will make the Operation fast and highly reliable.
The relay circuit, connected & tuned to the supply frequency must rejects the harmonics produced by current transformer saturation & due to system disturbances.
The current transformers may develop voltages during maximum internal faults and the relay may be damaged. Therefore total impedance of the relay to be decided by using

external series stabilising resistor (non-linear resistor) to prevent over voltage developed. The relay shall be single pole operated.

Features:
• High stability on external faults
• Tuned to rated frequency
• 25ms operating time at 5 times current setting
• Simple and robust construction.
• High stability on external faults.
• Sensitive high speed protection on internal faults.
• Tuned to rated frequency.

Application
• Differential/REF protection of Power Transformers, auto-transformers and busbars.
• Balanced and restricted earth fault protection of transformer windings.
• Transverse differential protection of generators and parallel feeders.

General description
In circulating current protection schemes, the sudden and often asymmetrical growth of the system current during external fault conditions can cause the protective current transformers to go into saturation, resulting in a high unbalance current. To ensure stability under these conditions the relay should be designed to take care, may be by using a voltage operated, high impedance relay, set to operate at a voltage slightly higher than that developed by the current transformers under maximum external fault conditions.
The stabilising resistor to be designed for such applications where sensitive settings with stability on heavy through faults are required.
A slight time delay on operation of relay helps to provide stability on heavy external faults and is to be taken care. This limits the current supplied, and the output unit operates only on the slower part of its time/current curve. The external stabilising resistor to be supplied separately with the relay allows continuous adjustment of the relay voltage setting over a wide range. y spaced current settings. The relay circuit, tuned to the supply frequency, rejects the harmonics produced by CT saturation. A slight time delay on operation helps to provide stability on heavy external faults and is obtain

TECHNICAL DATA
Current rating : 1A
Frequency : 50 Hz
Settings : 10 - 40% in seven equal steps as standard. Continuously variable external stabilising resistors of 200 ohms or any suitable value for 1A.
Operating time :
25 milliseconds at 5 times the current setting (see time/current characteristic in Figure 1).
Burdens :
0.9VA at current setting on lowest tap. 1.0VA at current setting on high set tap.
Accuracy :
Error class Index E 5.0 as per BS 142-1966 and 5.0 as per IS 3231-1965.
Operation indicator :
Hand reset operation indicator provided.
Contacts :
Two pairs of make self-resetting contacts are provided on single element relays.
Short time :
20 times the setting current for 3 seconds.

Thermal rating continuous :
(for 60 degree C rise in coil temperature): Times current setting To be furnished for different taps.
Case and finish :
Single pole relays fitted in size 3 MIDOS cases. The relay comply fully with the requirements of IS 3231-1965 and are suitable for use in normal tropical environments

Provision of Thermistor/ Metrosil :
To protect from high voltage- Suitable rating thermistor shall be provided.
Insulation :
The relay meets the requirements of IS 3231-1965/IEC 255-5 Series C-2 KV for 1 minute

3. HIGH SPEED TRIP RELAY

A. General

The relay should be multi-contact attracted armature relays conforming to IEC 60255-1 and ESI 48 – 4 EB 2.

1. The relay should be of high speed, high burden, positive action, instantaneous cutoff type.
2. It should be of high burden to give immunity to capacitance discharge current.
3. It should be of robust design for reliable service.
4. Should be draw out type.
5. The number of contacts:

i. 10 contacts (8NO+ 2NC)

6. It should have hand and electrical contact reset and hand flag reset.
7. The trip relay should be suitable for use in Substation Automation System.

A. Technical Data

Rated voltage VN	220 V DC
Operating range	50% to 120% of rated voltage
Operating time	10 ms at rated voltage
Reset time	< 20 ms at rated voltage VN
Contacts	Hand reset and Electrical reset
Flag	Hand reset
No of contacts	10 (8 NO + 2 NC)
Nominal Burden	Operating Coil: < 170 Watts
	Reset Coil: < 70 watts for 10 contacts
Contact Rating	Make and carry continuously 1250 VA AC or 1250 W DC within limits of 660 V and 5 A
	Make and carry for 3 s 7500 VA AC or 7500 W DC within limits of 250 V and 30 A
	Break 1250 VA AC or 100 W (resistive) DC or 50 W (inductive) DC within limits of 250 V and 5 A
Case type & Size.	Panel Cut out Max for i. 10 contacts : (50 X 170mm) ii. 20 contacts : (100 X 170mm) depth should be less than 250mm.

B. Tests.

i. Temperature :IEC 60068-2-1/ IEC 60068-2-2

Operating	-10°C to +55°C
Storage	-25°C to +70°C

ii. Humidity : IEC 60068-2-30/IEC 60068-2-78

Damp heat test, Cyclic	6 days at 250C to 400C and 93% relative humidity
Maximum Altitude of Operation	Up to 2000 m

iii. Mechanical Test

Test	Reference	Requirement
Vibration	IEC60255-21-1	Response Class I
Shock and Bump	IEC60255-21-2	Shock response and withstand Class I, Bump Class I
Seismic test	IEC60255-21-3	Class I
Degree of protection	IEC60529	IP50 – Front IP20 – Rear IP40 – Side
Electrical Endurance	IEC 60255-1	10,000 operations at the rate of 600 operations per hour at 250 VAC, 5A (Ref: Std IEC 61810-1)

iv Electrical Test

Test	**Standard**
Insulation Resistance	IEC 60255-27# 500 V DC, >100M Ohms Between all terminals & earth Between coil terminals & contacts
Impulse Voltage Withstand	IEC 60255-27# 5.0 kV, 1.2/50 µs, 0.5J Between all terminals & earth Between coil terminals & contacts
High Voltage (Dielectric)	IEC 60255-27# 2 kV, 50Hz@1min (2.2 kV for 1 s) Between all terminals & earth Between coil terminals & contacts 1 kV AC RMS for 1 min across normally open contacts
Thermal Withstand Continuous	IEC 60255-6 1.2 VN
Thermal withstand for 10 s	IEC60255-6 1.30 VN
Functional	IEC 60255-1
Maximum Allowable Temperature	IEC 60255-6 Max. temperature limit +1000C
AC Ripple on DC supply	IEC 60255-11 Withstand 15% AC ripple on DC

Power Frequency Magnetic Field Immunity	IEC 61000-4-8 Level 4, 30 A/m applied continuously 300 A/m applied for 3 s
Switching Rate	600 Operations per hour
Immunity to capacitance discharge	ENA TS 48-4 Issue 4 2010, Table

Protective system

6.7 Unit and backup protection

Power system elements and the network shall be provided with independent high speed discriminative protection systems. Duplicate schemes (Main I and Main II) shall be provided for all

400kV and 220kV systems. For all other systems up to 132kV, the protection equipment shall be divided into 'Main' and 'Backup' systems.

Protection schemes of different philosophy (Main I and Main II or Main and Back-up) shall preferably be fed from different DC supplies when available in the substation. This shall include energisation of trip coil circuits in case of 400 kV and 220 kV breakers. However in case of 132kV system where a duplicate DC source is available, the two trip coils shall be energised from the different sources.

Protection equipment shall not initiate a trip signal following the normal and correct discharge operation of one or more surge arresters.

Measurement functions relays must be achieved through electronic circuits. Auxiliary relays, repeat relays, trip relays and any other simple auxiliary or contact multiplication function may be based on standard attracted armature or other electromechanical techniques.

Relays based on numerical design technique shall constitute all primary protections. The Employers intends to avail the improved benefits in the functionality, design, reliability and cost effectiveness of integrated substation control systems in future for which relays with numeric design only shall be required. It is the responsibility of the Contractor to demonstrate that all relay equipment offered has a reasonable level of in-service experience. For numerical relays, the following conditions apply :

1. The Bidder must be able to demonstrate that a minimum of 10 relays of each type offered have been in full service without relay failures for a minimum of three years in two different countries, one of which may be the country of manufacture. Experience involving trial installations is not acceptable.

2. The Bidder must include a statement of the number of years of guaranteed manufacturing and parts support which will be provided for the relays offered.

3. The Bidder is be required to state the full firmware version together with the version of relays for which experience records are offered.

For relays which are provided with communication facilities, the communications facility should allow all information which is available locally at the relay front panel to be accessed remotely. It should also be possible to carry out bulk transfer of settings and fault record information using the appropriate PC based software.

6.8 Protection discrimination

On the occurrence of a fault on the power system network the high speed discriminating protection systems (main protection) shall rapidly detect the fault and initiate the opening of only those circuit breakers which are necessary to disconnect the faulted electrical element from the network. Protection equipment associated with adjacent electrical elements may detect the fault, but must be able to discriminate between an external fault and a fault on the electrical element which it is designed to protect. Sequential time delayed tripping is not permitted except in the following specific circumstances:

- Protection for short connections between post current transformer housings and circuit breakers when the technical advantages of complete overlapping of the protection are outweighed by economic considerations, (i.e. short-zone protection)
- Operation of time graded back-up protection takes place as a result of either the complete failure of the communication links associated with the main protection systems, or the fault resistance is substantially greater than a value which can be detected by main protection systems.
- Operation of line back-up protection to disconnect primary system faults in the case of a circuit breaker failing to operate, (i.e. circuit breaker failure protection)
- All back-up protection systems shall be able to discriminate with main protection systems, circuit breaker fail protection and with other back-up protection systems installed elsewhere on the transmission system.

6.8.1 Codes and Standards

The equipment supplied shall generally comply with the codes and standards indicated in relevant sections of this specification. Additionally the equipment shall also conform the requirements of this specification.

6.8.2 Environmental requirement

The protection, control and metering equipment shall operate satisfactorily under the various atmospheric, mechanical, electrical and environmental conditions as stipulated in the relevant sections of this Specification. The equipment shall conform to EMC Class III.

6.8.3 Future network scada system

At some time in the future the Employer intends to introduce a network SCADA system. All equipment to be installed under this Specification shall be suitable for future remote operation and remote data acquisition.

The limit of responsibility with regard to this contract shall be to provide equipment suitable for future connection to and communication with a SCADA system, either by means of RTU or modem. Neither the RTU nor the modems form part of the scope of this Specification.

The proposed protocol for the SCADA system is IEC 61850 compliance. Equipment necessary to interface the Integrated Substation Control System with the SCADA system are part of the scope of this Specification.

6.8.4 Control and monitoring levels

The substation control and monitoring system shall allow for three levels of man machine interface. The number of levels initially employed will be limited to one i.e. substation levels. Provision shall be made for the future implementation of the second and third level of network control and monitoring from a system control centre via SCADA.

Selection of substation control shall be from the individual equipment basis i.e., from the control panels.

At the station level, control panels should be located in the main control room.

A mimic diagram representing the substation lay-out in single line diagram form should be provided. The mimic board is intended to give operating personnel an overall view of the switchgear state. It shall be made up from the individual circuit control panels mounted side by side. The arrangement should correspond to the primary equipment layout.

Alarm annunciation equipment should be mounted adjacent to the mimic diagram, or form an integral part of the control panel. Operation of an alarm should cause the appropriate window to flash and sound an audible warning. Operation of an accept button will silence the audible warning, steady the flashing window and prepare the annunciation to respond to subsequent initiation. A reset button should be provided to extinguish alarms which have reset.

A lamp test button shall be provided which will initiate steady state illumination of all alarm windows. Trip or protection initiated alarms should have windows distinct from others (e.g. red display instead of white). Control and selector switches should be of approved types complying with accepted standards such as IEC 337. Control switches shall have two independent motions or two handed operation to effect operation. Indicating instruments should be of approved types complying with accepted standards such as IEC 5 1.

6.9 Enclosures

Protection systems shall preferably be accommodated in rack or hinged rack cubicles and be of modular construction with factory assembled and tested wiring. Conventional analogue relays may be mounted on conventional relay panels which must be mounted to allow access to the front and rear of the panel. Relays mounted on such panels shall be flush mounted. The construction method shall offer the benefits of minimum site construction times and circuit outage requirements.

Interconnections shall be identified in accordance with the requirements for dependent local end marking as specified in IEC Publication 391 Sections 3.4.1.a.1 and 5.1.2. The interconnections shall be recorded on an appropriate schedule or diagram.

For modular protection systems, means shall be provided to lock positively each withdrawable module or unit in the “service” position. It shall not be possible to remove any module without first short-circuiting all associated current transformer circuits.

6.10 Operator interface

6.10.1General

All numerical protection systems shall be provided with an integral local operator interface facility to enable communication with the relay without the use of external equipment. Any facilities provided

for connection to an external computer shall be an additional feature to the local operator interface. No exceptions to this requirement shall be accepted.

6.10.2 Identification

Each protection system shall have a unique identifier which is clearly visible. If the protection system is software operated the software reference and issue level shall be identified.

6.10.3 Settings

Each protection system shall provide a means by which the user can easily access the protection system to apply the required settings. This facility shall be secure from inadvertent operation. A display of the selected settings shall be provided on the protection system.

6.10.4 Indications

Each relay or protection scheme shall be provided with an adequate number of indications to ensure that the appropriate faulted phase, zone, etc. can be easily identified after a fault condition. Each indicator shall be visible and capable of being reset without removing the relay cover.

For relays based upon numerical techniques, indication shall be provided for failures detected in the protection relay or communications equipment. The indications provided shall be designed to allow the defective item to be quickly identified. The status of the DC power supplies shall be permanently indicated.

Details of the indication required for specific types of relay are provided in the individual parts of this section of the specification covering particular types of relay.

6.11 Protection system output contacts

All protection systems shall be provided with an adequate number of contacts of suitable rating to carry out the required tripping functions, alarm indications, fault recorder functions and such supplementary signalling functions as may be necessary for initiation of automatic switching control, inter tripping etc. In all cases contacts intended for tripping duty shall be designed such that they cannot inadvertently interrupt trip coil current.

6.12 Testing and isolating facilities

Each functional protection system shall be so arranged that operational and calibration checks can be carried out with the associated primary circuit(s) in service.

Adequate test facilities shall be provided within the protection system to enable the protection and auto-reclosing equipment to be tested from the front of the protection equipment panel with the primary circuit(s) in service. The test points shall be clearly identified and labelled.

Relays based on digital and numerical design techniques shall include supervision facilities which provide a periodic self check of the key elements within the relay and also provide continuous self monitoring of all internal power supplies and microprocessor operation. A defect in any of the self supervision facilities shall not cause maloperation of the protection relay internal self-test facilities and shall give an alarm should an internal fault occur.

Adequate facilities shall be provided, preferably at the front of each protection equipment panel, to isolate all DC and AC incoming and outgoing circuits so that work may be carried out on the equipment with complete safety for personnel and without loss of security in the operation of the switching station. The isolation points shall be clearly identified and labelled. The labels on the isolation points shall either describe the function or be uniquely numbered.

The Contractor shall provide a list of all of the protection and auto-reclose equipment being offered under the contract.

The Contractor shall also provide a list of all of the test and ancillary equipment required for commissioning and routine testing of all protection and auto-reclose equipment.

6.13 Service life and support

The protection systems shall be designed for a service life of at least 15 years, and preferably 20 years, given that normal maintenance in accordance with manufacturers recommendations is carried out during the lifetime of the protection system.

The Contractor shall state the service life of the protection system equipment in relation to that of the main HV plant and apparatus so that Employer can assess the cost of any replacement during the life of the substation.

The Contractor shall state the period for which lifetime support will be provided for the protection system equipment and shall make recommendations for the provision of spare parts.

The Contractor shall supply circuit diagrams for each protection system and the associated tripping system(s). The diagrams shall provide sufficient information to enable fault finding and maintenance to be carried out and shall not consist solely of information used for equipment manufacture.
When the Contractor has been notified of incorrect operation, or failure to operate when required, of any protection system supplied under the contract, the Contractor shall investigate the incident and inform Employer of any such incidents if they result in the necessity to modify the equipment. The Contractor shall also inform Employer of the details of the modifications required to prevent such incidents re-occurring.
The Contractor shall offer a service to enable any faulty item of protection equipment to be rectified or replaced within a stated period of the fault being reported. The Contractor shall state the repair/replacement period.
The Contractor shall, when requested, offer the Employer a maintenance contract for the protection equipment supplied under the contract. The Contractor shall supply details of the cost of the maintenance contract and information on test procedures and test frequencies that would be supplied under the maintenance contract.
The Contractor shall offer training for Employer's personnel in the operation and maintenance of the protection equipment.

6.14 Thermal rating of equipment

Relay equipment intended to perform a current measurement function shall be capable of continuous operation at a current of not less than 2.4 times the nominal rating or twice the setting value, whichever is the more onerous.
Relay equipment intended for use in a normally quiescent mode and having a short time rating - for example, high impedance differential protection - shall be rated in accordance with the intended function and taking account of such inherent protective devices as may be incorporated in the design.
The short time rating for all protection relaying schemes shall be 100 times the nominal relay rating for a duration of one second.
Voltage sensitive equipment intended for use on effectively earthed networks shall have a continuous withstand of not less than 1.2 times nominal voltage and a short duration withstand of not less than 1.5 times nominal phase-to-ground voltage for 30 s.

6.15 Insulation

The rated insulation voltage of circuits connected to current transformers of high impedance relays shall be 1000 V. All other circuits shall have an insulation voltage of 2500V.
All open contacts of the protection system shall withstand a voltage of 1000V. The protection system shall comply with the dielectric test requirements of IEC 255-5. The test voltage shall be selected according to the rated insulation voltage of the circuits being tested form SeriesC of Table1 of IEC 255-5. The protection system shall comply with the impulse test requirements of IEC 255-5 with test voltage of 5kV.

6.16 Test requirements

6.16.1 General requirements

The Contractor shall supply test results and/or in service operating evidence to confirm compliance with the general and performance requirements as detailed in this Specification.

6.16.2 Pre-commissioning and energisation tests

The Contractor shall submit details of all pre-commissioning and energisation tests to the Project Manager for approval prior to the tests, and shall provide the Project Manager with the opportunity to witness the commissioning tests.

6.16.3 Testing, inspection and test certificates

The Bidder shall enclose with his bid the reports of type and routine tests conducted on similar equipment earlier as a proof of designing and developing similar equipment. Bid documents, furnished without these test reports shall be considered as incomplete and shall be liable for rejection. All equipment furnished shall conform to the type tests and shall be subject to routine tests in accordance with the requirements stipulated for control and relay panel equipment. The Project Manager reserves the option to call for any or all the type tests to be repeated on the equipment. The Project Manager further reserves the option to intimate the type tests to be carried out on the equipment up to six months after the award of contract. Payments would be made for the type tests actually carried out in accordance with the rates given in the Bid Price Schedule.

The Project Manager will have the right to call for any other tests of reasonable nature to be carried out at the Contractor's premises or at site or in any other place, in addition to the aforesaid type and routine tests, to satisfy that the materials comply with the Specification.

The Contractor shall advise the Project Manager three months in advance of the type tests to be conducted on the finished equipment giving a programme for conducting the tests and shall proceed to test the equipment only after approval of the Project Manager. All type tests shall be performed in presence of Project Manager should he so desire.

The Contractor shall give one months notice of routine tests and inspection to be carried out on the finished equipment. A programme for conducting the tests shall be furnished and the Contractor shall proceed to test the equipment after approval of the Project Manager. The tests shall be witnessed by the Project Manager should he so desire.

All inspections, type tests and routine tests shall be carried out after approval of all the relevant drawings required under the contract.

None of the equipment to be furnished or used in connection with this contract shall be despatched until factory tests are satisfactorily completed. Such factory tests on the equipment shall not however relieve the Contractor from full responsibility for furnishing equipment conforming to the requirements of this contract, nor prejudice any claim right or privilege which the Employer may have because of the use of defective or unsatisfactory equipment. Should the Project Manager waive the rights to inspect and test any equipment, such a waiver shall not relieve the Contractor, in any way, of his obligations under this contract.

Six (6) copies of test reports of successful tests shall be submitted by the Contractor to the Project Manager for approval before shipment of equipment.

For equipment tests for which IEC recommendations or Indian Standards are available, test reports confirming that the equipment has passed the specified type and routine tests shall be furnished for the approval of the Project Manager by the Contractor before shipment of the equipment.

For equipment/tests for which IEC/IS specifications do not exist, the Contractor shall propose a test procedure for the approval of the Project Manager before conducting tests. Test certificates for tests carried out shall be submitted for approval of the Project Manager before shipment of the equipment.

Failure of any equipment to meet the requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works in accordance with the agreed programme.

The Employer reserves the right to call for field tests on the completely assembled equipment at site.

The price for conducting all the type tests in accordance with relevant standards and specifications shall be indicated in Bid Price Schedule and these would be considered for bid evaluation. The break-up price of type tests shall be given in the relevant price schedule for payment purpose only. In case Bidder does not indicate charges for any of the type tests or does not specifically identify any test in the price schedules, it will be assumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to rejection.

Six (6) copies of all test reports shall be supplied for approval before shipment of equipment. The reports shall indicate clearly the standard values specified for each test, to facilitate checking of the test reports. Fourteen (14) bound copies of test reports shall be submitted along with the equipment after approval of test results.

6.16.4 Soak test

All solid state equipment/system panels shall be subject to the Hot Soak Test as a routine test in accordance with the procedure detailed in the following paragraph.

All solid state equipment shall be burn-in tested for minimum of 120 hours continuously under operational conditions. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 50C. Each panel shall be complete with all associated sub-systems and the same shall be in operation during the above test. During the last 48 hours of the above test, the temperature inside the panel shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65C.

6.16.5 Type tests

Impulse voltage withstand test as per Clause 6.1 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS-8686)

High Frequency Disturbance test as per Clause 5.2 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS 8686)

Type tests listed under IEC-Technical Committees recommendation `TEC-57' and functional type tests listed under **CIGRE Study Committee 34** (Protection) Report on simulator, Network analyser or PTL as applicable.

6.16.6 Routine tests

Contact insulation resistance test as per Clause 10.5 of IS-3231.
Insulation withstand capability as per Clause 10.5 of IS-3231 on all AC/DC relays.

7.0 Protection Schemes

7.1 General

The following sections of this specification identify the protection requirements for specific schemes. Drawings showing single line diagrams for each type of circuit are included in this Specification. The arrangements shown on these drawings represent the minimum requirements. Other protection arrangements may be provided but the Bidder must clearly state the reasons for offering supplementary protection schemes.

7.2 Technical requirements

Technical requirements of the protection and auxiliary relays, recorders and meters to be provided as part of the scope are detailed I the following sub clauses.
The setting ranges of the equipment offered, if different from that specified shall be acceptable if they meet the functional requirements. The Bidder shall quote for protection equipment meeting the requirements given in these sub clauses.
The Bidder may also quote alternative or additional protections or relays considered necessary by him for providing an effective and reliable protection scheme. These equipments shall be quoted separately as an alternative or addition to the main offer. The Employer reserves the right to accept or otherwise such equipment.

7.3 400kV Reactor protection

Protection requirement

The 400 kV reactors provided with the lines shall have the following protections**.**

- Differential protection.
- Restricted earth fault protection.
- Backup impedance protection.

7.3.1 Differential protection relay (87R)

This relay shall :

1. Be triple pole type
2. Have operation time less than 25 milliseconds at five times setting.
3. Be tuned to system frequency.
4. Have three instantaneous high set units to ensure rapid clearance of heavy faults with saturated CT's.
5. Have current setting range of 10 to 40% of 1 Amp.
6. Be Low impedance type.
7. Be stable for all external faults.
8. Be provided with suitable non-linear resistors to limit the peak voltage to 1000 volts.

7.3.2 Restricted earth fault protection relay (64 R)

This relay shall:

1. Be single pole type
2. Be of current/voltage operated high impedance type
3. Have a current setting of 10-40% of 1A and a suitable voltage setting range.

4. Be tuned to system frequency.

5. Be fitted with suitable non-linear resistors to limit the peak voltage to 1000 volts.

7.3.3 Back up impedance protection relay (21 R)

This relay shall:

1. Be triple pole type

2. Be single step polarised `mho' distance relay or impedance relay suitable for measuring phase to ground and phase to phase faults.

3. Have an ohmic setting range of 20-320 ohms and shall be continuously variable.

4. Have an adjustable characteristic angle of 30 to 80 degree.

5. Have a definite time delay with a continuously adjustable setting range of 0.2 - 2.0 seconds. Shall initiate three phase tripping

7.4 BUS BAR PROTECTION:

Bus bar protection schemes shall be provided for each main and transfer bus of 400 KV and 200 KV provided in the switch yard. This shall constitute main and check features. The overall scheme shall be engineered such that operation of both main and check features connected to the faulty bus shall result in tripping of the same. The scheme shall be provided with necessary expansion capacity and interfaces for adding features when the switch yard is extended in future to its ultimate capacity. The bus bar relay shall be of latest numerical relay having IEC protocol 61850 compliance.

7.4.1 Busbar protection (Latest version numerical having IEC-61850 protocol compliance)

Bus bar protection schemes shall be provided for each main bus of 400kV and 220kV switchyard. The overall scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same. However in case of transfer bus, where provided, only one busbar protection scheme shall be required.

Each busbar protection scheme shall

1. Be of modular construction and have features of self monitoring facility to ensure maximum availability of scheme. The scheme shall be static/ microprocessor/ Numerical based.
2. Have maximum operating time up to trip impulse to trip relay for all types of faults of 15 milli seconds at 5 times setting value.
3. Operate selectively for each busbar.
4. Give hundred percent security up to 40kA fault level.
5. Incorporate a check feature.
6. Incorporate continuous supervision for CT secondaries against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate alarm.
7. Not give false operation during normal load flow in busbars.
8. Incorporate clear zone indication.
9. Be of phase segregated and triple pole type and provide independent zones of protection for each bus (including transfer bus if any). If a bus section is provided then each side of the bus section shall have separate busbar protection scheme.
10. Include individual high speed hand reset tripping relays for each feeder, including future ones.
11. Be of low/medium impedance biased differential type and have operate and restraint characteristics.
12. Be transient free in operation
13. Include continuous DC supplies supervision.
14. Shall include multitap auxiliary CT's for each bay including future bays as per SLD and also include necessary CT switching relays wherever CT switching is involved.
15. Include protection 'in/out' switch for each zone with at least six contacts for each switch.
16. Shall have CT selection incomplete alarm wherever CT switching is involved.

17. Have necessary auxiliary relays to make a comprehensive scheme.
At existing substations busbar scheme with independent zones for each bus will be available. All necessary co-ordination for 'CT' and 'DC' interconnections between existing schemes (panels) and the bays proposed under the scope of this contract shall be fully covered by the bidder. Any auxiliary relays, trip relays, flag relays required to facilitate the operation of bays covered under this contract shall be fully covered in the scope of the bidder.
The Contractor shall offer all equipment to meet the requirements as above to make the scheme full and comprehensive.

7.4.2 Weatherproof relay panels

Where required these panels shall be provided for busbar differential protection. The panels shall include necessary number of electrically reset relays each with at least eight contacts for isolator auxiliary contact multiplication and for changing the CT and DC circuits to relevant zone of protection.
The panel shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 3.0 mm thick and properly braced to prevent movement. The enclosures of the panel shall provide a degree of protection of not less than IP55 (as per IS 2147). The constructional requirements shall comply with the relevant section of this Specification.
Two test terminal blocks required for bus coupler bay CT connection shall be supplied and mounted inside the panel of adjacent bay.

The test terminal blocks shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. Such blocks shall have washer and binding screws for external circuit wire connections, a white marking strip for circuit identification and moulded plastic cover. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring. Terminal block shall have shorting, disconnecting and testing facilities for CT circuits.

7.5 Bus coupler / transfer bus coupler protection

The protection scheme for the above are to be provided with directional numerical over current and earth fault protection scheme . The relay shall be latest version numerical and IEC 61850 compliant for future SCADA purpose.The details as indicated under unit back up protection relay.
All 220 kV substations shall be of Double Main (DM) or Double Main and Transfer (DMT) busbar configuration and shall be provided with a single bus coupler circuit breaker. In addition 220 kV DMT busbar configurations shall be provided with a transfer bus coupler circuit breaker. The required protection equipment for these breakers comprises overcurrent and earth fault relays. These relays shall comply with the requirements for backup over current and earth fault protection as described elsewhere in this section, except that the relays shall not be directional. The earth fault element shall have a current setting range of at least 20 - 80 per cent in six equal steps.

All 132 and 33 kV substations shall be of Single Main and Transfer (SMT) busbar configuration and a bus section isolator. Overcurrent and earth fault protection, complying with the requirements as given elsewhere in this section but without directional feature, shall be provided.

In DMT/SMT configurations, whenever the main breaker of a feeder or transformer is substituted by the bus coupler or transfer bus coupler breaker, a facility for switching over of the trip function of the feeder or transformer relays from the main breaker to the bus coupler or transfer bus coupler breaker, shall be provided through provision of a lockable protection transfer switch. The provision of a key interlock on the above switch is to be so arranged that at one time only one feeder or transformer can be taken to transfer mode.

7.6 Circuit breaker monitoring auxiliary relays

All circuit breakers shall be provided with several relay contacts for annunciation of circuit breaker conditions such as :

- Low air/hydraulic oil/gas pressure.
- Lockout conditions due to abnormally low air/hydraulic oil/gas pressure.
- Pole discrepancy trip.
- Compressor/hydraulic pump trouble.

The exact requirements for this shall be available in the circuit breaker drawings to be provided by the manufacturer. The programmable Inputs/Outputs of the numeric relays shall be used as much as possible for providing annunciation in the control room for such cases. In case this is found inadequate, suitable auxiliary flag relays may be provided in the relay panels to provide annunciation.

8.0 Event logger (**)

**As per the customers requirement

All 400 and 220 KV sub-station shall have separate Event Logger panel provision.

8.1 General

The event logger shall be used to record the open and close states of switch yard equipment, relays and changes of alarms.

The function of the equipment should be based on programmes stored in it. The stored programmes should permit some degree of flexibility of operation. Facility should be provided to erase the existing programme and reprogram allowing changes to be made very easily.

The number of modules and different types of modules should be minimised. The modules should be of plug-in type and should be easily accessible to simplify maintenance and repair.

The equipment should be designed to operate satisfactorily in severely hostile electrical environment such as in 400kV/220kV switchyard which are prone to various interference signals, typically from large switching transients.

The equipment should be carefully screened, shielded, earthed and protected.

Input/ Output circuits should withstand the following tests:

- Impulse test in accordance with IEC 255, Part-IV.
- High frequency disturbance test in accordance with IEC 255, Part-IV.

Since the equipment will be used in dedicated non-attended situations, programme stability is vitally important. Programme must not be capable of being changed unintentionally during normal operation.

8.2 Construction

The equipment should be constructed in clearly defined plug-in modules. A monitor module should be provided for indicating internal faults such as processor failure, memory failure, other internal hardware failures, and also external plant failures. These failures should be displayed on the LED's mounted on the monitor module. The equipment is used to record changes in digital points, i.e. operations and resetting of alarms and switching of primary equipment within a substation. Approximately 500 points should be accommodated in a single equipment. When such changes occur, a print out on a local teletype writer, which forms a part of this contract, should result.

The date and time should be printed to the nearest 10 ms followed by a message describing the point which has operated. Such messages may be abbreviated or in full English forms. Events occurring whilst a previous event is in process of being printed are to be stored to await printing. Over 100 such events must be stored. Facility shall exist to synchronise the internal clock system which will give a pulse output every half an hour with a pulse duration of at least 50 milliseconds through potential free contracts. However, if master clock system is not available, time generator of any one of the disturbance recorder shall be taken as master and event logger(s) in that station will be synchronised with it. The event logger shall give annunciation in case of absence of synchronising pulse within a specified time window. The internal clock of the event logger shall be such that the drift is limited to □0.5 seconds per day, if allowed to run without time synchronisation.

The print out of current alarm and plant stages must be available on request by the operator. the operator should also be able to enter the date and time from the key board.

8.3 Technical requirements

The event recorder shall record all changes of alarms and plant states of switchyard equipment, along with the date and time of all alarms and plant state changes to the nearest 10 ms.

Facility shall be provided to commit 50 points of sequential memory or 25% of alarm whichever is the greater. In addition the unit shall be capable of handling up to 40 changes in any one 10 ms interval and 500 alarms and changes of state of switchyard equipment.

On receipt of an alarm the equipment must:

- Print out a message on Printer

- Set off an audible alarm.
- Set off a beacon.

Allow normal inputs of

- Accept
- Alarm demand log
- Plant state demand log
- Date and time

The Bidder shall furnish along with the offer a two copies on original paper typical print out for simulated conditions.

Only plain paper readily available in India shall be used for the printer. The arrangement of feeding and removing paper rolls or stacks shall be quick and simple. The width of paper shall be 216 mm approximately. The Bidder shall provide as part of his scope of supply, consumables for up to six months operation.

Event printout of the shall contain as a minimum the following:

- Station identification.
- Date and time (in hour, minutes, seconds and milliseconds).
- Event number.
- Event description (at least 40 characters).

The auxiliary power supply required for the event logger, VDU and printer shall be either 220V DC or 110V DC (as available in the station) with voltage variation of + 10% to -20%. Any other power supply that may be required for proper functioning of the equipment has to be derived by the Bidder from his own equipment which shall form an integral part of the event logger station.

Bidder shall supply VDU, printer and keyboard arrangement.

At existing substations where an event logger is provided, Bidder shall provide necessary potential free contracts of various relays/equipment for plant and alarm states and shall co-ordinate with existing event logger for proper logging of events.

A combined solution of disturbance recorder and event logger function with a VDU, key board and a printer is also acceptable.

9.0 Synchronising equipment

Where required synchronising equipment shall be provided along with this Contract.

The synchronising instruments shall be mounted on a synchronising trolley. The trolley shall be equipped with double voltmeter, double frequency meter, synchroscope and lamps fully wired. The trolley shall be of mobile type with four rubber padding wheels capable of rotating in 360 degree around the vertical axis. Suitable bumpers with rubber padding shall be provided around the trolley to prevent any accidental damage to any panel in the control room while the trolley is in movement.

The trolley shall have two metre long flexible cord fully wired to the instruments and terminated in a plug in order to facilitate connecting the trolley to any of the panels. The receptacle to accept the plug shall be provided on the panel.

Synchronising check relay with necessary ancillary equipment shall be provided. This shall permit breakers to close after checking the requirements of synchronising of incoming and running supply. The phase angle setting shall not exceed 35 degree and have voltage difference setting not exceeding 10%. This relay shall have a response time of less than 200 milliseconds when the two system conditions are met within present limits and with the timer disconnected. The relay shall have a frequency difference setting not exceeding 0.45% at rated value and at the minimum time setting. The relay shall have a continuously adjustable time setting range of 0.5-3 seconds. A guard relay shall be provided to prevent a closing attempt by means of synchronising check relay when control switch is kept in closed position before the two systems are in synchronism.

Suitable auxiliary voltage transformers, wherever necessary, shall also be provided for synchronising condition. In case the synchroscope is not continuously rated, a synchroscope cut-off switch shall be provided and an indicating lamp to indicate that the synchroscope is energised, shall also be provided.

Each circuit for which a synchronous closure is required shall be provided with a lockable synchronising selector switch which shall be used to select the voltage signals (incoming and running

voltage) appropriate for that circuit. The provision of a key interlock shall ensure that at any one time only one feeder / transformer can be synchronised.

10.0 Time synchronisation equipment for substation

The Bidder shall offer necessary time synchronisation equipment complete in all respects including antenna, all cables, processing equipment etc. required to receive co-ordinated universal time (UTC), transmitted through GEO Positioning Satellite System (GPS).

The time synchronising system should be compatible for synchronisation with event loggers, disturbance recorders, relays, computer systems and all other equipment provided in the protection, control and metering system of the substation wherever required.

Equipment should operate up to an ambient temperature of 50C and 100% humidity. The synchronisation equipment shall have two microsecond accuracy. Equipment should give real time corresponding to IST (taking into consideration all factors such as voltage and temperature variations, propagation and processing delays etc.

Equipment should meet the requirement of IEC 255 for storage and operation. The system should be able to track the satellites to ensure no interruption of synchronisation signal.

The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

The equipment offered shall have six output ports. Various combinations of output ports shall be selected by the Project Manager, during detailed engineering, from the following:

1. Voltage signal : 0-5V continuously settable, with 50 ms. minimum pulse duration.
2. Potential free contact : minimum pulse duration of 50 ms
3. IRIG-B & SNTP
4. RS232C

The equipment should have a periodic time correction facility of one second periodicity.

Time synchronisation equipment shall be suitable for operation from 220V DC as available at substation with a voltage variation of +10% and -20%. Any other power supply that may be required for proper functioning of the equipment shall be derived by the Bidder from his own equipment which shall form an integral part of the system.

Equipment shall have real time digital display in hour, minute, second (24 hour mode) and have a separate time display unit to be mounted on the top of control panels having display size of approximately 100 mm height.

Bidder shall quote unit rates for each type of output port for the purpose of addition/deletion.

Schedule of Quantities

11.0 General

Protection, control, metering panels and associated equipment to be located in switchyard control rooms at various substations shall be offered as panels/systems/modules of following description. The quantities are given at the end of this section.

Sl. No.	Description of Panels	Control Panel type and designtation	Relay Panels type and designtation
1	Line protection panel:		
1.1	400kV line-4CT,5CT (1 $^1/_2$ breaker scheme)	CPF4H	RPF4H
1.2	220kV line-DMT	CPF2D	RPF2D
1.3	132kV line—MT	CPF1M	RPF1M
1.4	33kV line—MT	CPF0M	RPF0M
2	Transformer protection panel:		
2.1	400/220kV Auto-	CPH4H	RPH4H
	Transformer	CPL2D	RPL2D
2.2	220/132kV Auto-	CPH2D	RPH2D
	Transformer	CPL1M	RPL1M
2.3	220/33kV power	CPH2D	RPH2D

	Transformer	CPL0M	RPL0M
2.4	132/33kV power Transformer	CPH1M	RPH1M
		CPL0M	RPL0M
3	Reactor protection panel:		
3.1	Bus reactor	CPR4H	RPR4H
3.2	Line reactor	CPS4H	RPS4H
4.1	Transfer bus coupler		
	220kV line-DMT	CPT2D	RPT2D
	220kV line-T	CPT2T	RPT2T
4.2	Bus coupler		
	220kV line-DMT	CPB2D	RPB2D
	132kV line—MT	CPB1M	RPB1M
	33kV line—MT	CPB0M	RPB0M
4.5	Bus sectionaliser	CPZ2D	RPZ2D

11.1 Type designations for the various panels

The panels are designated by a alpha-numeric code consisting of five characters (AAANA) through out this schedule in this specification to represent their use for various applications. Their representation shall be as here under:

Character position	1 2	3	4	5
Character representation	AA	A	N	A

H	$1^1/_2$ breaker scheme
D	Double main and transfer switching scheme
M	Main and transfer switching scheme
S	Single bus
T	Two mains bus switching scheme
R	Ring main bus switching scheme

0	33kV
1	132kV
2	220kV
4	400kV

F	Feeder
H	Transformer High Voltage Side
L	Transformer Low Voltage Side
R	Bus reactor
S	Shunt(line) reactor
T	Transfer bus coupler
B	Bus coupler and Bus bar
Z	Bus sectionaliser
C	Capacitor bank protection
V	Bus bar
M	Diameter with Transformer and Feeder
N	Diameter with Feeder and Feeder
O	Diameter with Feeder and Feeder
P	1/2 Diameter with Single Feeder
Q	1/2 Diameter with Single Feeder with Reactor

CP	Control panel
RP	Relay panel
KP	Common panel

11.2 Bill of quantities for individual panels

Each panel described above shall constitute the equipment as detailed here under . The quantities of each type of equipment are minimum. The bidder may include additional devices in the panels depending upon the design and requirements as per stipulations of the specification.

Control panel (CPANA)

		CPA4H / CPA2H	**CPA2D /CPA1M /CPA2T**	**CPA1M /CPA0S / CPA0T**
Sl. no	**List of equipment**	**Quantities required for each panel**		
		For 400kV / 220kV and 1 $^{1}/_{2}$ breaker scheme	**For 220kV and 132kV**	**For 33kV**
1.	Ammeter (Digital)	3 Nos. for each bay (1 for each bay in case of 220 kV) + 1No. for reactor (as per requirement)	1No. (2 Nos. for Bus section coupler)	1No.
2.	Wattmeter (Digital)	1 No. for each bay	1 No. (2 Nos. for Bus section coupler)	1 No.
3.	VARmeter (Digital)	1 No. for each bay + 1 No. for line reactor (as per requirement)	1 No. (2 Nos. for Bus section coupler)	1 No.
4.	Voltmeter (Digital)	1 No. for each bay	1 No. for each bay	1 No. (only in bus coupler panel)
5.	Digital voltmeter with selector switch	1 set for new substation in any one specific control panel	1 set for new substation in bus coupler panel	Not required
6.	Digital frequency meter	1 set in any one specific control panel	1 set in bus coupler panel	1 set in bus coupler panel
7.	Solid state trivector type energy meter for recording export, import of MWH, MVA and MVARH with MDI.	NOT REQD	NOT REQD	NOT REQD
8.	Winding temperature indicator	Not required	Not required	Not required
9.	Discrepancy control switch for breaker	1No. for each circuit breaker	1No. for each circuit breaker	1 No. for each circuit breaker

10.	Discrepancy control for isolator	1No. for each isolator	1No. for each isolator	1No. for each isolator
11.	Discrepancy control for earth switch	one for each earth switch	one for each earth switch	one for each earth switch
12.	Mimic to represent SLD	one for each panel	one for each panel	one for each panel
13.	Ammeter selector switch	one for line reacter (as per requirement)	one for each panel	one for each panel
14.	Voltage selector switch	one for each bay	one for each bay	one for each volt meter (only in buscoupler Bay)
15.	DC source selector switch	one for each panel	one for each panel	one for each panel
16.	Indicating lamps			
16.1.	Red indicating lamps for ON	one for each isolator, earth switch and circuit breaker	one for each isolator, earth switch and circuit breaker	one for each isolator, earth switch and circuit breaker
16.2.	Green indicating lamps for OFF	one for each isolator, earth switch and circuit breaker	one for each isolator, earth switch and circuit breaker	one for each isolator, earth switch and circuit breaker
16.3.	White indicating lamp for circuit breaker healthy	one for each circuit breaker	one for each circuit breaker	one for each circuit breaker
16.4.	Indicating bulb for circuit breaker control position (Local/Remote) (If required)	two for each circuit breaker	two for each circuit breaker	two for each circuit breaker
16.5.	Blue indicating lamp (for spring charge)	one for each circuit breaker	one for each circuit breaker	one for each circuit breaker
16.6.	for annutiation D.C. fail	one in any one specific control panel	one in bus coupler pannel	one in buscoupler pannel
16.7.	for Annunciation A.C. fail	one in any one specific control panel	one in buscoupler pannel	one in buscoupler pannel
16.8.	for flasher healthy	one in any one specific control pannel	one in buscoupler pannel	one in buscoupler pannel
16.9.	for Busbar VT secondary healthy	three for each bus in any one specific control panel	three for each bus in buscoupler pannel	three for each bus in buscoupler pannel
17.	Push buttons			
17.5.	for alarm accept	one for each panel	one for each panel	one for each panel
17.6.	for alarm reset	one for each panel	one for each panel	one for each panel
17.7.	for lamp test	one for each panel	one for each panel	one for each panel
17.8.	for audio alarm reset	one in any one specific control panel	one in buscoupler pannel	one in buscoupler pannel
17.9.	for annunciation D.C. fail accept	one in any one specific control	one in buscoupler pannel	one in buscoupler

		panel		pannel
17.10.	for annunciation D.C. fail test	one in any one specific control panel	one in buscoupler pannel	one in buscoupler pannel
17.11.	for annunciation A.C. fail accept	one in any one specific control panel	one in buscoupler pannel	one in buscoupler pannel
17.12.	for annunciation A.C. fail test	one in any one specific control panel	one in buscoupler pannel	one in buscoupler pannel
18.	Annunciation windows with necessary annunciation relays	24 for each feeders bay 24 for each treansformer bay 24 for each Tie	24 for each feeders panel 24 for each transformer panel 24 for each Tie and each bus coupler panel	18 for each feeders panel 18 for each transformer panel 18 for each bus coupler panel
19.	Synchronising socket	one for each circuit breaker	one for each circuit breaker	Not required
20.	Bus CVT selector switch (as per requirment)	one for each panel	one for each panel	one for each panel
21.	Protection trip transfer switch (TTS)	not required	one for each panel	one for each panel
22.	Reactor de-interlocking push button	one for each circuit breaker bay (where applicale)	not required	not required
23.	Hooter	one for each new sub-station	one for each new sub-station	one for each new sub-station
24.	Buzzer	one for each new sub-station	one for each new sub-station	one for each new sub-station

11.3 Line protection panel (RPLNA)

The line protection panel or panels may be a single panel or more panels to accommodate all the equipments listed below. However, for bay extension, new panels must match the existing panels in all respect.

		Quantities required			
Sl. No	**Equipment**	**400kV RPL3H**	**220kV RPL2A**	**132kV RPL1A**	**33kV RPL0A**
1	Main-I protection scheme (composite numerical distance protection relay with auto reclosing and check syncronising facility)	1 set	1 set	1 set	Not required
2	Main-II protection scheme(composite numerical distance protection or phase comparision relay with auto reclosing and check syncronising facility)	1 set	1 set	Not required	Not required
3	Composite numerical directional & or non-directional over current and earth fault relay.(selectable Features Dir & Non Dir)	1 set	1 set	1 set	1 set
4	Over voltage/ Under voltage protection scheme (if not available in the main-I& II protection module)	1 set	1 set	1 set	Not required
5	Selector switch for carrier in/out for main-I	2 Nos.	2 Nos.	1No.	Not

	and main-II protection scheme				required
7	Disturbance recorder (if not available in the distance protection or main protection module)	1 set	1 set	1 set	Not required
8	Distant-to-fault locator for phase and earth faults(if not available in the distance protection or main protection module)	1 set	1 set	1 set	Not required
9	CVT selecting relays or switches (depending on switching scheme)	1 set	1set	1set	Not required
10	Test terminal blocks for Main-I/ Main II/other protection relay	1 set for each module	1 set for each module	1 set for each module	1 set for each module
11	Auxiliary relays for carrier supervision of Main-I and Main II protection relays (depending on its application)	1 set	1 set	1 set	Not required
12	Carrier receive lockout relay (depending on its application)	1 set	1 set	1 set	Not required
13	Breaker failure protection scheme	1 set	1 set	1 set	1 set
14	Trip circuit pre and post supervision relays for trip coil I and II	1 set	1 set	1 set	1 set
15	DC supply supervision relay	1 set	1 set	1 set	1 set
16	Flag relays for circuit breaker trouble shooting	1 set	1 set	1 set	1 set
17	Trip relays single/three phase for group-A	1 set	1 set	1 set	1 set
18	Trip relays single/three phase for group-B	1 set	1 set	1 set	1 set
19	Trip relays single/three phase for LBB	1 set	1 set	1 set	1 set
20	Under Frequency Relay(in built feature of O/C & E/F relay)	1 set	1 set	1 set	1 set

11.4 Transformer protection panel(RPHNA and RPLNA)

The transformer protection panel or panels may be a single panel or more panels to accommodate all the equipments listed below. However, for bay extension, new panels must match the existing panels in all respect.

		Quantities required		
Sl. No	**Equipment**	**For each High Voltage panel of 400/220kV and 220/132kV transformers**	**For each High Voltage panel of 220/33kV and 132/33kV transformers**	**For each Low Voltage Panel of transformers**
1	Main-I Transformer composite numerical protection comprising of the following: • Differential protection • Restricted earth fault protection • Over fluxing protection	1 set	1 set	Not required
2	Main-II Duplicated numerical protection as Main-I	1 set	Not required	Not required

3	Composite numerical directional over current and earth fault protection relay(selectable Features Dir & Non Dir)	1 set	1 set	1 set
	Restricted earth fault protection (Electromechanical of high impedance with Stabilising resistor & metrosil)	1 set	1 set	1 set
4	Over load protection (if not included in sl.no. 1 and 2 above)	1 set	1 set	1 set
5	Over voltage/ Under voltage protection scheme (if not available in the main protection module)	1 set	1 set	Not required
6	Flag relays for thermal imaging, MOG, WTI, OTI, Bucholz, PRV,OSR and status indication etc.. (1.MOG-Al,2.WTI,BUCH,OTI – Al & Trip,3. PRV,OSR – Trip)	1 set	1 set	Not required
7	Solid state trivector type energy meters for measurement of export/ import of MWH, MVA and MVARH with MDI.	1 set	1 set	1 set
8	CVT/PT selection relays (depending upon the the switching scheme of the system)	1 set	1 set	1 set
9	Breaker failure protection scheme	1 set	1 set	1 set
10	Trip circuit pre and post supervision relays for trip coil I and II.	1 set	1 set	1 set
11	DC supply supervision relay	1 No for each panel	1 set	1 set
12	Flag relays for circuit breaker trouble shooting	1 set	1 set	1 set
13	Trip relays three phase for group-A	1 set	1 set	1 set
14	Trip relays three phase for group-B	1 set	1 set	1 set
15	Test terminal blocks for all protection relays	1 set for each module	1 set for each module	1 set for each module

11.5 Transfer bus coupler (RPT2D) / Bus coupler and Busbar (RPBNA) protection panel

Bus bar protection panel shall be equipped to accommodate all present and future bays.

Sl. No	Equipment	Quantities required			
		RPB4H	RPB2A	RPB1A/ RPB0A	RPT2D
1.	Composite numerical Directional Over current and earth fault protection (selectable Features Dir & Non Dir)	1 set	1 set	1 set	1 set
2.	Test terminal block for all protection relays	1 set for each module	1 set for each module	1 set for each module	1 set for each module
3.	Trip circuit pre and post supervision relays for trip coil I and II	Not required	1 set	1 set	1 set
4.	DC supply supervision relay	Not required	1 set	1 set	1 set

5.	Flag relays for circuit breaker trouble and status indication etc.	Not required	1 set	1 set	1 set
6.	Breaker failure protection scheme	Not required	1 set	1 set	1 set
7.	Trip relays single/three phase for group-A	Not required	1 set	1 set	1 set
8.	Trip relays single/three phase for group-B	Not required	1 set	1 set	1 set
9.	Bus bar differential relay for Bus-I	1 set	1 set	Not required	Not required
10.	Bus bar differential relay for Bus-II	1 set	1 set	Not required	Not required
11.	CT switching/selection relays(if required)	1 set	1 set	Not required	Not required
12.	Bus bar differential relay for Check Zone	1set	1set	Not required	Not required

At existing substations, necessary trip relays and auxiliary relays required shall be included in the offer to accommodate the new bays for existing bus bar protection schemes.

11.6 Common equipment (RPKNA)

Sl. No	Equipment	Quantities required
1.	Bus-I voltage recorder	1 No.
2.	Bus-II voltage recorder	1 No.
3.	Bus-I frequency recorder	1 No.
4.	Bus-II frequency recorder	1 No.
5.	Bus-I & Bus-II Digital Volt meter	1 Set
6.	Bus-I & Bus-II Digital Frequency meter	1 Set
7.	Event logger(Separate panel)	1 No.

11.7 Bus sectionalizer protection panel

Sl. No	Equipment	Quantities required
1.	Composite numerical directional Over current and earth fault protection relay(selectable Features Dir & Non Dir)	2 sets
2.	Test terminal block for all protection relays	1 set
3.	Trip circuit pre and post supervision relay for trip coil I and II	2 No
4.	DC supply supervision relay	1 No
5.	Flag relays for circuit breaker trouble and status indication etc.	2 No
6.	Breaker failure protection scheme	2 set

7.	Trip relays three phase for group-A	2 set
8.	Trip relays three phase for group-B	2 set
9.	Bus bar differential relay for Bus-I (numerical type- IEC -61850)	1 set
10.	Bus bar differential relay for Bus-II (numerical type- IEC -61850)	1 set
11.	CT switching/selection relays	1 set
12.	Bus bar differential relay for Check Zone (numerical type- IEC -61850)	1set

11.8 Synchronising panel

Synchronisation panels are required for new substations and addition of new voltage (132kV and above) to existing substation.

Sl. No	Equipment	Quantities required
1	Double Voltmeter (0-150v range)	1 no for each panel
2	Double Frequency meter (45-55Hz)	1 no for each panel
3	Synchroscope	1 no for each panel
4	Synchronizing relay	1 set for each panel

**** ALL THE RELAYS SHALL BE OF NUMERICAL VERSION HAVING IEC 61850 PROTOCOL COMPLIANCE.ALL CARE SHALL BE TAKEN IN DESIGNING THE PROTECTION SYSTEM FOR FUTURE SCADA PROVISION. THERE SHALL BE ADEQUATE NO OF INPUT AND OUT PUT CONTACTS FOR USE. SHALL HAVE SELF SUPERVISING AND INTERNAL FAULT DETECTING/DIAGNOSING FACILTY. SUFFICIENT FAULT /DISTURBANCE RECORDING FACILITIES.**

12.0 ERECTION AND MAINTENANCE TOOL EQUIPMENT:

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished. The testing plug shall be supplied along with the panels for conducting testing of relays. These testing plug should be suitable for test terminal box provided in the panel.

12.1 TROPICALISATION:

Control room will be normally air-conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot,humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring,equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

12.2 RELAY TEST KIT

One relay test kit shall comprise of the following equipment as detailed hereunder.

1. Relay tools kits: 3 Sets
2. Test plugs: 2 Nos
3. Special type test plugs for using with modular type cases(if applicable): 1 No

13.0 ADDITIONAL INFORMATION ON SWITCHES ETC.

13.1 SWITCHES:

1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

2. The selection of operating handles for the different types of switches shall be as follows.

Purpose	Type
Breaker, Isolator control switches	Discrepancy type
Synchronizing switches	Oval, Black, keyed handle (having common key for a group of switches)
Synchronizing selector switch	Oval or knob, block
Instrument switches	Round, knurled, black
Protection transfer switch	Pistol grip, lockable & black

** In case the rotary switches are provided for breaker and isolator control Semaphores are also to be provided along with the switches.

3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip position to “after close” and “after trip” position respectively.
4. Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make before break type contacts so as to prevent open circuiting of CT secondary when charging the position of the switch. Voltmeter transfer switch for AC shall be suitable for reading all line to line and line to neutral voltage for non effectively earthed systems and for reading all line to line voltages for effectively earthed systems.
5. Synchronising switches shall be of maintained contact (stay put) type having a common removable handle for a group of switches. The handle shall be removable only in the off position and it shall be coordinated to fit into all the synchronizing switches. These shall be arranged to connect the synchronizing equipment when turned to the “on” position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the ON position.
6. Lockable type switches which can be locked in particular position shall be provided when specified. The key locks shall be fitted on the operating handles.
7. The contacts of all the switches shall preferably open and close with snap action to minimizing the arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy Springs shall not be used as current carrying parts.
8. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.
9. The contact rating of the switches shall be as follows.

Description	Contact Rating In Amperes		
	220 V DC	50 V DC	230 V AC
Make & carry continuously	10	10	10
Make & carry for 0.5 sec	30	30	30
Break for			
i) Resistive load	3	20	7
ii) Inductive load (L/R=40ms)	0.2	-	-

13.`2 INDICATING INSTRUMENTS, RECORDERS & TRANSDUCERS:

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All megawatt, megavar, bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with the transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronizing equipment.

13.2.1 Indicating Instruments:

1. All electrical indicating instruments shall be of digital type suitable for flush mounting.
2. Shall have 4 digit display, display height being not less than 25mm.
3. Shall confirm to relevant IS and shall have an accuracy class 1.5and or better watt and Var meters shall have an indication of (+) and (-) to indicate Export and Import respectively.
4. Digital voltage and frequency meters shall be of 0.5 class and shall have digital display of 5 and 4 digits respectively, with display size not less than 25mm height.

13.14.2 Bus voltage & Frequency recording instruments:

1. Shall be static/digital type frequency and voltage recorder either as individual units or composite unit for total sub-station with time tagged information shall also be applicable if it meets the accuracy of ± 1.0% span and full span response time of less than 2 seconds. The static/digital shall also meet the high voltage susceptibility test, impulse voltage with stand test ,high frequency disturbance test-class III and fast transient disturbance test level III as per IEC -60255.

13.2.3 Transducers:

1. Transducers shall in general confirm to IEC-688-1
2. Shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.
3. Transducers shall have input from sub-station current and voltage from the instrument transformers. The output shall be in miliampere D.C proportional to the input and shall feed the output current to the indicating instruments /telemetry terminals.
4. Characteristic shall be linier throughout the measuring range.
5. Output shall be load independent.
6. Input and output shall be galvanically isolated.
7. Transducers should work satisfactorily at 120% of rated value continuously.
8. Shall have 4-20mAmp.
9. Response time shall be less than 1 sec.
10. Accuracy class shall be 1 or better voltage/current, 0.5 or better for watt/var and 0.2 or better for frequency transducers.
11. Shall have a low AC ripple on output less than 1%.
12. Shall be suitable for load resistance of 1000 – 1500.
13. Shall have dual output.

Test programme for distance relays

General Comments:

1. These test cases are evolved from the report of working group 04 of study committee 34 (Protection) on evaluation of characteristics and performance of power system protection relays and protective systems. For any further guidelines required for carrying out the tests, reference may be made to the above document.
2. The test shall be carried out using network configuration and system parameters as shown in the figure-1
3. All denotations regarding fault location, breakers etc are referred in figure –1
4. The fault inception angles are referred to R- N voltage for all types of faults
5. The fault inception angle is zero degree unless otherwise specified
6. Where not stated specifically, the fault resistance (Rf) shall be zero or minimum as possible in simulator
7. Single pole circuit breakers are to be used
8. The power flow in double source test is 500 MW

System Parameters System voltage =400KV; CTR= 1000/1

PTR = 400000/110 (with CVT, the parameters of CVT model are shown in figure –2)

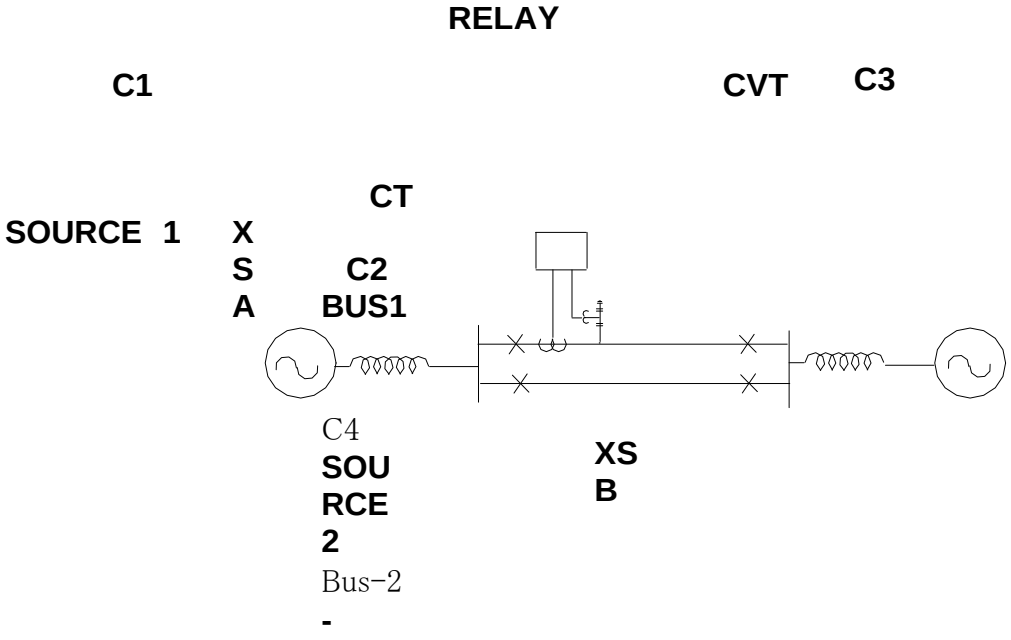

Figure-1

Line parameters/km

Positive Sequence Resistance, (r1)	= 0. 02897 Ω
Positive Sequence Reactance (x1)	= 0.3072 Ω Zero Sequence
Resistance (r0)	= 0.2597 Ω Zero Sequence
Reactance (x1)	= 1.0223 Ω Zero Sequence
Mutual Resistance (rm)	= 0.2281 Ω Zero Sequence
Mutual Reactance (xm)	= 0.6221 Ω Zero Sequence
succeptance (bo)	= 2.347 µ mho Positive
Sequence succeptance (b1)	=3.630 µmho

Types of Line	Short		Long
Secondary Line Impedance	2 Ω		20 Ω*
Length of Line in Km	23.57		235.7
SIR	4	15	4
Source impedance (pry) (at a time constant of 50 ms)	29.09 Ω (5500 MVA)	109.09 Ω (1467 MVA)	290.9 Ω (550 MVA)

* Alternatively , the tests can be done with 10 Ω secondary impedance and source impedance may accordingly be modified.

CVT Model:

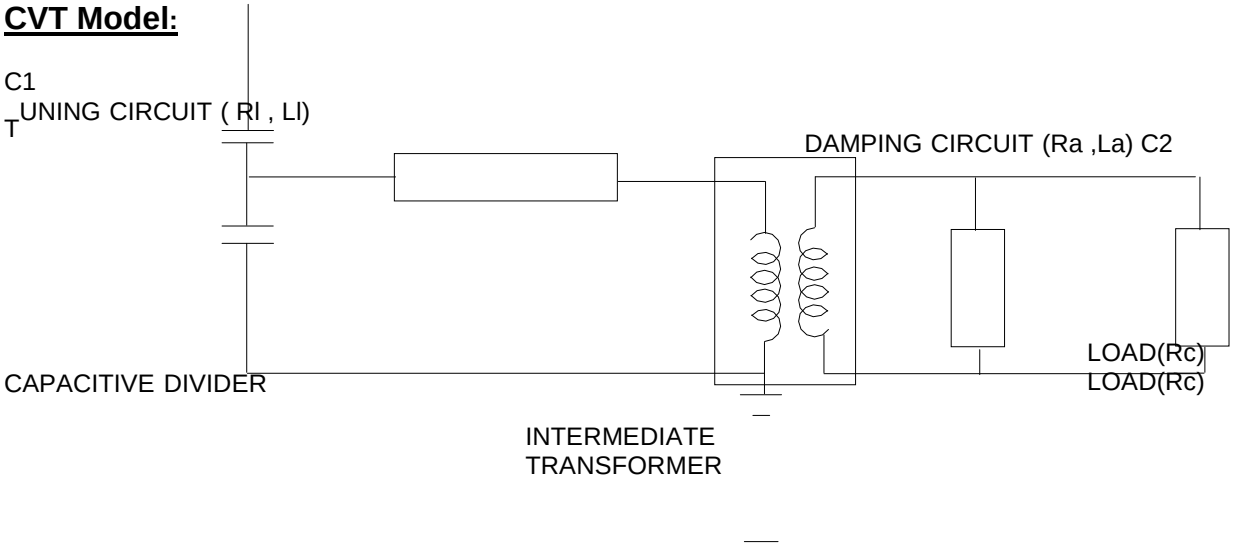

Figure-2

XC1 : 1.455 µ mho,XC2 : 27.646 µ mho
Rl : 320 Ω , Xll : 34243 Ω, Ra : 4.200 Ω, Xla : 197.92 Ω,Rc : 14.00 Ω, Transformation ratio of : 181.8 Intermediate transformer**.**

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

SPLIT TYPE INDIVIDUAL UNIT AIR CONDITIONER

TECHNICAL SPECIFICATION FOR AIR CONDITIONING SYSTEM

1.0 GENERAL

The specification covers supply, installation, testing and commissioning and handing over of Air conditioning system for the control room building

The AC units for control room building shall be set to maintain the following inside conditions.
DBT 24.4 Deg C ± 2 Deg C

1.1 The following room shall be air conditioned

a) Control Room
b) Conference room
c) Testing lab

1.2 Air conditioning requirement of rooms indicated shall be met by using split AC units. High wall type split AC units of required capacity as per design (to be submitted for approval) with high wall type indoor evaporator unit shall be used. In case the area is more than ductable split AC units may also be designed for better effect.

1.3 The exact quantity of the split AC units shall be designed taking the room area and the same may be proposed for necessary approval. However 2 TR capacity split AC units of **5 star** rating to be considered. The quantity shall be approximately as mentioned below.

PROPOSED NO OF A.C UNITS SHALL BE OF ~~5 STAR RATING~~: INVERTER TYPE WITH COPPER CONDENSER

1) FOR ALL 220/132/33 KV S/S CONTROL ROOM AREA
   A) 20 NOS 2 TR CAPACITY.
   B) 220/33 KV S/S:15 NOS 2 TR CAPACITY.
2) FOR ALL 132/33 KV SUB-STATION: 15 NOS 2 TR CAPACITY.
3) FOR 400/220 KV S/S CONTROL ROOM: 30 NOS 2 TR CAPACITY

1.4 Copper refrigerant piping complete with insulation between the indoor and remote outdoor condensers as required.

1.5 SCOPE: The scope of the equipment to be furnished and services to be provided under the contract are outlined herein and the same is to be read in conjunction with the provision contained. The scope shall be deemed to include all such items which although not specifically mentioned in the bid documents and/or in bidders proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

1.6 Unit should be hermetically sealed

1.7 PVC drains piping from the indoor units up to the nearest drain point to be done.

1.8 Power and control cables between the indoor unit and outdoor unit and earthing

1.9 GI brackets for for outdoor condensing unit and proper earthing.

1.10 Specification for Split AC units.

The split AC units will be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

Out door units shall comprise of hermetically sealed rotary compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils assembled in a sheet metal. The casing and the total unit shall be properly treated and shall be weather proof type. They shall be compact in size and shall have horizontal discharge of air.

The indoor unit shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by special motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multifunction cordless remote control unit with special features like programmable timer, sleep mode and softy dry mode etc.

The split AC units shall be of Carrier/Blue Star/Hitachi/Voltas/Samsung/LG make.

The air conditioner unit should be provided with a required voltage stabilizer (from 90 V to 275 V AC).

2. PROVISION OF AIR-CONDITIONING SYSTEM IN THE SWITCYARD KIOSK OR ANY UNMANNED STATION AS SPECIFICALLY ASKED FOR:

The descriptions of the units are as indicated below:

The Air Conditioning system with voltage stabilizer, which shall be provided in the Building/kiosk. These Building/kiosk shall be generally unmanned; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life. The air conditioning is required for critical application i.e. for maintaining the temperature for critical sub-station GIS/AIS equipment, control and protection equipment. To provide redundancy for such critical applications, the building shall be installed with environment control system comprising of the units of air conditioners working in conjunction through a micro processor based controller for desired operation. The system shall be designed for 24 Hours, 365 Days of the year to maintain the inside the building/kiosk temperature to a suitable temperature (23 +2 deg C) or as decided. The required nos. of the air conditioners shall be running at a time and the failure of any one unit or as described here under the standby/other unit shall automatically run to ensure longer life of the air conditioning system. The redundant unit shall also be running in cycle operation (for a cycle time of 4 hours /12 hours user defined) through the controller. However during running of the air conditioner unit if the inside temperature of the building reaches to a pre-defined (30 deg C) the other shall start running to maintain the temperature to a specified value (23 +2 deg C). After achieving this temperature the standby/other unit shall again shut off.

Capacity: Main Unit having dual compressor minimum of 2TR each & Stand by Unit having dual compressor minimum of 2TR each.

Compressor Type: Scroll

Power supply: 230 V,50 Hz

Controller: Microprocessor control & should have provision of monitoring the temperature from the Main control room with integration facility to SAS.

Voltage stabiliser, control boxes etc for completing the A.C scheme.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

1-COAXIALCABLES

2-CONTROL & POWER CABLES

TECHNICAL SPECIFICATION

ITEM- H.F. CO-AXIAL CABLE, CONTROL CABLE & TELEPHONE CABLE

SCOPE

The specification covers the design, manufacture, testing before dispatch and setting to service of the following cables for their utility in power line carrier communication system in OPTCL.

1. H.F. Co-axial cable
2. Control cable
3. Telephone cable
4. H.F. Co-axial cable

General:

(a) The H.F.C0-axial cable shall be offered to connect the coupling unit (Line Matching under Symmetrical LMU) with PLC terminals. This serves maximum transfer of power between the carrier equipment to HT lines with minimum losses. The cable is also used for interconnection between two line matching units.

(b) The high frequency cable to be offered shall be suitable for being laid in the ground or in trenches or in ducts. It shall be duly armoured and confirm IS:5802 of 1978.

(c) The center core of the cable shall consists of tinned or enameled higfh purity copper conductor which has to be insulated by polythene sheath and shall be screened by tinned copper braidings. This braiding shall be sheathed by a PVC cover and GI wire enamoured and overall PVC sheathed and shall be suitable for tropical use. The six, type and quality of insulation shall be stated in the tender.

(d) The capacitance of the co-axial cable shall be low as to minimize attenuation at the carrier frequency range.

Tentative Particulars:

1.	Cable impedance	125 ohm or 75 ohm unbalanced. (both shall be quoted
2.	Centre conductor	0.8 mm dia
3.	Dia over insulation	7.6 mm
4.	Thickness of insulation	1.75 mm
5.	Outer conductor	Braiding of tended copper (Electrolytic grade) wire of 0.2 mm dia with 90% coverage
6.	Barrier	Malinex tape
7.	Inner Sheath	Special cable grade PVC (Black/Gray) Radial Thickness – 1.2mm.
8.	Braiding & Armouring	Single braid of 0.3mm GI wire with 79% coverage.
9.	Overall sheath	Special cable grade PvC(Black/Gray) Radial thickness-1.4 mm
10.	Diameter over	16.0 mm (maximum)
11.	Maximum Conductor resistance	35.33 ohms/Km.
12.	Dielectric strength (Core to shield)	5 KV rms ro 1 minute.
13.	Characteristic capacitance at 1 KHz	36.10 pf/meter
14.	Maximum attenuation at various frequencies	
	Frequency (KHz)	ds/KM
	10	0.8
	60	1.4

	300	3.30
	500	4.70
15.	Minimum bending radios for installation	20 CM
16.	Insulation resistance	Meg. Ohm/Km(Min.)

2. Telephone Cable:

1) The telephone cables are of armoured or unarmoured type depending on the requirements. The telephone cable shall have 0.5 or 0.6 mm annealed tinned copper conductor, PVC insulated, cores colour coded, twisted into pairs, laid up, taped and overall PVC sheathed confirming to ITD specification. In case of armoured cable, it must be GI wiser/strip armoured with inner and outer sheathed confirming to IS: 1554 (Part-I)/1976.

2) The following cables may be quoted in the tender.

(1) 25 pair Armoured telephone cable
(2) 10 pair Armoured telephone cable
(3) 10 pair unarmoured telephone cable
(4) 5 pair unarmoured telephone cable.

3) The following cables may be quoted in the tender.

(1) 2.5 sq.mm twin core (solid)
(2) 10 sq.mm multistrand twin core.

4) tests – Type Test reports shall be furnished.

TECHNICAL SPECIFICATION FOR

CONTROL AND POWER CABLES

PART 1 : SCOPE AND CONDITIONS

1. **SCOPE**

This specification covers the testing and performance requirements of power and control cables for installation on the Distribution System to be established at the loaction as indicated against this tender.

The equipment offered shall have been successfully type tested and the design shall have been in satisfactory operation for a period not less than two years on the date of bid opening. Compliance shall be demonstrated by submitting with the bid, (i) authenticated copies of the type test reports and (ii) performance certificates from the users..

The power and control cables shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the Project Manager shall have the power to reject any work or material, which, in his judgement, is not in full accordance therewith.

2. STANDARDS

Except where modified by this specification, the power and control cables shall be designed, manufactured and tested in accordance with the latest editions of the following standards.

IEC / ISO	Indian Standard	Title
IEC 811	IS-18-10810:1982	Testing cables
IEC 502	IS-7098:1985 (part 2)	LT and 3.3 - 33kVXLPE cables
IEC 502	IS - 1554:1988 (part 1)	PVC Cables .65/1.IkV
IEC 227	IS - 5819 :1970	Short circuit ratings for PVC cables
IEC 228	15-8130:1984	Conductors for insulated cables
IEC 502	IS - 6474: 1984	XLPE Cables
IEC 502		Extruded solid dielectric insulated power cables for rated voltages from IkV to 30kV
IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths of electric cables and cords
IEC 287		Calculation of the continuous current rating of cables.
IS - 3975 : 1979		Mild steel wires, strips and tapes for armouring of cables

The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Acceptability of any alternative standard is at the discretion of the Project Manager. The Bidder shall furnish a copy of the alternative standard proposed along with his bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In the case of conflict the order of precedence shall be 1) IEC or ISO Standards, 2) Indian Standards, 3) other alternative standards.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the goods complying with other relevant standards or recommendations.

3. SERVICE CONDITIONS

The service conditions shall be as follows:

- maximum altitude above sea level l1,000m
- maximum ambient air temperature 50°C
- maximum daily average ambient air temperature 35°C
- minimum ambient air temperature o°C
- maximum temperature attainable by an object exposed to the sun 60°C
- maximum yearly weighted average ambient temperature 32°C
- maximum relative humidity 100%
- average number of thunderstorm days per annum (isokeraunic level) 70
- average number of rainy days per annum 120
- average annual rainfall 150cm
- wind pressures as per IS 802 (Part I/ Sect.l) : 1995

Wind Zones (Orissa)	**2**	**3**	**5**
Terrain Category 1	**57.4 kg/m^2**	**73.1 kg/m^2**	**94.3kg/m^2**
Terrain Category 2	**49.3**	**62.6**	**80.9**
Terrain Category 3	**35.6**	**45.3**	**58.4**
	Light	**Medium**	**Heavy**

Environmentally, the region where the work will take place includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive and humid coastal atmosphere.

4. SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics:

- Frequency 50Hz
- Nominal system voltages 33kV

		llkV
		400/230V
• Maximum system voltages:	33kV System	36.3kV
	llkV System	12.1kV
	LV System	476V
• Minimum LV voltage		340V
• Nominal short circuit levels:	33kV System	25kA
	llkV System	12.5kA
• Insulation Levels:		
1 .2/50 (j.s impulse withstand voltage		
(positive and negative polarity):	33kV System	170kV
	llkV System	75kV
• Power frequency one minute withstand		
voltage (wet and dry) rms	33kV System	70kV
	1 IkV System	28kV
	LV System	3kV
• Neutral earthing arrangements:	33kV System	solidly earthed
	llkV System	solidly earthed
	LV System	solidly earthed

PART 2 : TECHNICAL

All power and control cables to be used in the OPTCL distribution system shall be of the cross-linked polyethelene (XLPE) or polyvinyl chloride (PVC) insulated with PVC sheathing types.

8. 1.1KV POLYVINYL CHLORIDE (PVC) INSULATED CABLES

8.1. RATED VOLTAGE AND TEMPERATURE

The rated voltage of the cable shall be l.l kV and the maximum operating voltage shall not exceed 110% of the rated voltage.

These cables are suitable for use where the combination of ambient temperature and temperature rise due to load results in a conductor temperature shall not exceeding 70°C* under normal operation and 160°C under short circuit conditions.

*See 13.2.4 for heat resisting and general purpose applications.

8.2. CABLE DESIGN

ALL LV Power cable shall be of XLPE insulation armoured type.

The cable offered shall be single-core, four core or multi-core armoured or unarmoured XLPE insulated / PVC insulated, PVC sheathed to meet the following requirements:

8.2.1. Conductor

- L.V System Cables (Power Cable XLPE insulated)

  The conductor shall be of compacted round shape in single core cables and sector shaped in 3.5 or 4 core cables, made up from stranded aluminum wires complying with IS -8130:1984 / IEC 228. The Cable shall be of XLPE insulated with armoured.

  Cables with reduced neutral conductors shall comply with the cross-sections shown in the table below.

- Control and Panel Wiring Cables (PVC insulated)

  The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/IEC 228.

The conductors shall be of Flexibility Class 2 as per IS - 8130 : 1984.

8.2.2. Cross-Sectional area of reduced Neutral Conductors:

Nominal cross-sectional area of main conductor (mm2)	25	35	50	70	95	120	150	185	240	300	400	500	630
Cross-sctional area of reduced neutral conductor (mm^2)	16	16	25	35	50	70	70	95	120	150	185	240	300

8.2.3. Conductor Screening Not required

8.2.4. Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. The 'General Purpose' Type A shall be used for the LV cables and 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
General Purpose	70°C	160°C
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulation shall not be less than the specified nominal value and the maximum value not more than O.lmm plus 0.1 of nominal and as specified in IS - 1554(part 1): 1988. The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.

8.2.5. Insulation Screening Not required

8.2.6. Core Identification and Laying Up of Cores 3.5 and 4 core cables shall be identified by colouring of the PVC insulation and multi core by numbers as per IS- 1 554 (part 1): 1988

Panel wiring shall have a single colour except for power supplies which shall be as per the above IS standard.

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

8.2.7. Inner Sheath

The laid up cores of the 3.5, 4 and multi core cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

8.2.8. Armouring Only the 3.5 and 4 core LV cables will be armoured. The armour shall be applied helically in a layer of steel wires over the inner sheath of the cable. The armour shall consist of round or flat steel wires and comply with the requirements of IEC 502/IS - 1554: 1988. The steel wires shall comply with IS - 3975:

8.2.9. Outer Sheath

An outer sheath of polyvinyl chloride (PVC) shall be applied over the armour wires (where fitted). The sheath shall be embossed at regular intervals as per the Cable Identification clause of this

specification and the minimum thickness and properties shall comply with the requirements of IEC 502/IS - 1554: 1988. The outer sheath for cables with general purpose insulation shall be of the type ST1 PVC compound and for cables with heat resisting insulation type ST2 PVC compound conforming to the requirements of IEC 502/IS - 5831: 1984.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a l0kV DC test voltage for five minutes after installation and annually thereafter.

Cables shall be installed as a single four core cable or three single phase cables plus neutral in a close trefoil formation.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

8.2.10. Conductor Sizes

- The following conductor sizes will be used on the Employer's LV distribution system: 300, 120 and 50 mm^2 single core, 300 mm^2 three and a half core and 120 mm^2 four core.
- The following shall be used for Control and Panel Wiring:
  2.5 mm^2 single core, 2. 5 and 4.0 mm^2 four core and 1.5 and 2.5 mm^2 multicore

8.2.11. Cable Drum Length

The cable shall be supplied in 500metre lengths.

Technical Specification for Power and Control Cables

CABLE IDENTIFICATION

The manufacturer's and Employer's name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only done on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

The following code shall be used to designate cables:

Constituent	Code Letter
Aluminium conductor	A
XLPE insulation	2X
PVC insulation	Y
Steel round wire armour	W
Non-magnetic round wire armour	Wa
Steel strip armour	F
Non-magnetic strip armour	Fa
Double steel round wire armour	WW
Double steel strip armour	FF
PVC outer sheath	Y

Note: No code letter is required for copper conductor

10. SAMPLING OF CABLES

10.1. Lot

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

10.2. Scale of Sampling

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

10.3. Sampling Rates

The number of samples to be selected shall be as follows:

Number of drums in the Lot	Number of Drums to be taken as samples	Permissable number of defective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

1 1 . NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in 8.3 the lot shall be declared as conforming to the requirements of acceptance test.

1 2. TESTS ON 1 . 1 KV PVC INSULATED CABLES

12.1. Type Tests

Certification of type tests already completed by independent test laboratories shall be presented wiyh the bid for each cable type. These tests shall be carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified.

Type testing of 33kV,l IkV and 1.1 kV cables shall include the following:

Test	Requirement Reference	Test Method as a Part of IS-10810/IEC 811
(a) Tests on conductor		
Annealing test (copper)	IS-8130: 1984/IEC 502	1
Tensile test (aluminium)	IS-8130: 1984/IEC 502	2
Wrapping test (aluminium)	IS-8130: 1984/IEC 502	3
Resistance test	IS-8130: 1984/IEC 502	5
(b) Tests for Armour wires/strips	IS - 3975: 1979/IEC 502	36 - 42
(c) Tests for thickness of insulation and sheath	IS-5831:1984/IEC 540	6
(d) Physical tests for Insulation		
Tensile strength and elongation at break	IS-5831:1984/IEC 540	7
Ageing in air oven	IS-5831:1984/IEC 540	11
Hot test	IS-5831:1984/IEC 540	30
Shrinkage test	IS-5831:1984/IEC 540	12
Water absorption (gravimatic)	IS-5831:1984/IEC 540	33
(e) Physical tests for outer sheath		
Tensile strength and elongation at break	IS-5831: 1984/IEC 540	7

Ageing in air oven	IS-5 831: 1984/IEC 540	11
Shrinkage test	IS-5831: 1984/IEC 540	12
Hot deformation	IS-5831: 1984/IEC 540	15

Test	**Requirement Reference**	**Test Method as a Part of IS-10810/IEC811**
Loss of mass in air oven	IS-5831: 1984/IEC540	10
Heat shock	IS-5831: 1984/IEC540	14
Thermal stability	IS-5831: 1984/IEC540	IS-5831: 1984 Appendix B
(f) Partial discharge test (11 and 33kV only)	Section 13.2 of this specification	46
(g) Bending test (11 and 33kV only)	Section 13.2 of this specification	50
(h) Dielectric power factor test (11 and 33kV only)	Section 13. 4 of this specification	48
As a function of voltage		
As a function of temperature		
(j) Insulation resistance (volume resistivity) test	IS-8130: 1984/IEC502	43
(k) Heating cycle test (11 and 33kV only)	Section 13.5 of this specification	49
(1) Impulse withstand test (11 and 33kV only)	Section 13.6 of this specification	47
(m) High voltage test	Section 13.7 of this specification	45
(n) Flammability test	Section 13.8 of this specification	53

Tests (g), (h), (j), (1) and (m) are only applicable to screened cables.

Not withstanding the conditions of the above paragraph the following tests on screened 11 and 33kV cables shall be performed successively on the same test sample of completed cable.

1. Partial discharge test
2. Bending test followed by partial discharge test
3. Dielectric power factor as a function of voltage
4. Dielectric power factor as a function of temperature
5. Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests
6. Impulse withstand test
7. High voltage test

If a sample fails in test number 7, one more sample shall be taken for this test, preceded by tests 2 and 5.

12.2. Acceptance Tests

The following shall constitute acceptance tests:

- Tensile test (aluminium)
- Annealing test (copper)
- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation*
- Tensile strength and elongation at break test for insulation and outer sheath
- Partial discharge test (for screened cables only)**
- High voltage test
- Insulation resistance (volume resistivity) test.

• XLPE insulation only

** test to be completed on full drum of cable

12.3. Routine Tests

Routine tests shall be carried out on all of the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- Partial discharge test (for 1 IkV and 33kV screened cables only)*
- High voltage test

* test to be completed on full drum of cable

12.4. Optional Test

Cold impact test for outer sheath (IS - 5831 - 1984), which shall be completed at the discretion of the Project Manager and at the same time as test at low temperature for PVC as stipulated in the section on special tests.

12.5. Special tests

Special tests shall be carried out at the Project Manager's discretion on a number of cable samples selected by the Project Manager from the contract consignment. The test shall be carried out on 10% of the production lengths of a production batch of the same cable type, but at least one production length. Special tests shall be carried out in accordance with the requirements of IEC 502 and IEC 540 unless otherwise specified.

The following special tests shall be included:

- Conductor Examination (IEC-228)
- Check of Dimensions
- 4-Hour High Voltage Test for 11 kV and 33kV Cables only
- Hot set test for XLPE Insulation

- Test at low temperature for PVC

13. DETAILS OF TESTS

13.1. General

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

13.2. Partial Discharge Test

Partial discharge tests shall only be made on cables insulated with XLPE of rated voltages above 1.9/3.3kV.

For multicore cables, the test shall be carried out on all insulated cores, the voltage being applied between each conductor and the metallic screen.

The magnitude of the partial discharge at a test voltage equal to 1.5Uo shall not exceed 20pC for XLPE and 40pC for PVC, where Uo is the power frequency voltage between the conductor and earth or J metallic screen.

13.3. Bending Test

The diameter of the test cylinder shall be 20 (d +D) ± 5% for single core cables and 15 (d+D) ± 5% for multicores, where D is the overall diameter of the completed cable in millimetres and d is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

13.4. Dielectric Power Factor Test

13.4.1. Tan δ as a Function of Voltage

For cables of rated voltage 1.1 kV and above

The measured value of tan δ at Uo shall not exceed 0.004 and the increment of tan δ between 0.5 Uo and 2 Uo shall not be more than 0.002.

13.4.2. Tan δ as a Function of Temperature For cables of rated voltage 1.1 kV and above

The measured value of tan 8 shall not exceed 0.004 at ambient temperature and 0.008 at 90°C for XLPE cables.

13.5. Heating Cycle Test

The sample which has been subjected to previous tests shall be laid out on the floor of the test room and subjected to heating cycles by passing alternating current through the conductor until the conductor reaches a steady temperature 10°C above the maximum rated temperature of the insulation in normal operation. After the third cycle the sample shall subjected to a dielectric power factor as a function of voltage and partial discharge test.

13.7. High Voltage Test

13.7.1. Type/Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to 3Uo, when applied to the sample between the conductor and screen/armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

13.7.2. Routine Test

Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

13.7.3. Test Voltages

The power frequency test voltage shall be 2.5 Uo + 2kV for cables at rated voltages, up to and including 3.8/6.6kV, and 2.5 Uo for cables at higher rated voltages.

Values of single phase test voltage for the standard rated voltages are as given in the following table:

Voltage Grade kV	Test Voltage	
	Between conductors and screen/armour kV(rms)	Between conductors kV(rms)
0.65/1.1	3	3

If, for three core cables, the voltage test is carried out with a three phase transformer, the test voltage between the phases shall be 1.732 times the values given in the above table.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

13.8. Flammability Test

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharred) from the lower edge of the top clamp shall be at least 50mm.

14. CABLE ACCESSORIES

The accessories are for the following types of cable:

33kV XLPE, single core round stranded plain aluminium conductor to IEC 228/IS - 8130: 1984, semi-conducting conductor screen, XLPE insulation, non - metallic semi-conducting insulation screen with non - magnetic tape or metallic cover,inner PVC sheath, non-magnetic wire or strip armour and PVC outer sheath.

11kV XLPE, single or three core round stranded plain aluminium conductor to IEC 228/IS - 8130: 1984, semiconducting conductor screen, XLPE insulation, non - metallic semiconducting insulation screen with non - magnetic tape or metallic cover, inner PVC sheath , non-magnetic wire or strip armour for single core cables, and steel wire armour on three core cables and PVC outer sheath.

LV (1100V) PVC, single, three and a half and four core round or sector shaped stranded plain aluminium grade H4 conductor, PVC insulation, inner PVC sheath, steel wire armour for three phase cables and P.V.C. outer sheath.

14.1. JOINTS AND TERMINATIONS

Joints and terminations shall be supplied in complete kit form with all materials and components required to complete the installation. A complete set of instructions for the joint or termination shall also be included in each kit.

Heat shrink pre-moulded joints and terminations shall be required for all XLPE and PVC cables and for transition joints.

All components shall be capable of being stored without damage or deterioration at temperatures up to 50°C. The material expiry date shall be marked on all packages, where appropriate.

Details of all equipment, tools and protective clothing required to complete the joint or termination shall be included with each joint or termination kit.

Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable joints or terminations and shall not increase the rate of corrosion of any metals with which they may come into contact.

Components supplied with adhesive coatings shall have means to prevent the coated surfaces from adhering to each other.

Joints and terminations for armoured or screened cables shall include all items needed for wire or tape clamping. Rings shall be provided for such application.

The recovered thickness of insulation over the connector shall be uniform and equal to or greater than the cable insulation thickness as given in IEC 502/IS - 1554/IS - 7098.

The protection provided by the galvanised steel wire armouring shall be reinstated over the joint (s). Electric field stress control shall be provided on all of the High Voltage joints and terminations.

Joints shall provide waterproofing, mechanical and electrical protection, and be completely sealed from cable jacket to cable jacket. Joints shall accommodate crossing of the cores.

Where required 33kV, 1 IkV and 1.1 kV cable joints shall be straight through joints only.

Terminations shall be designed to provide a complete moisture seal, including the crotch area of multi-core cables and complete rejacketing of the individual cores, conforming to Class 1 terminations as per IEEE 48. They shall be generally suitable for indoor and outdoor installation, be resistant to ultra violet radiation and chemical attack.

Minimum creepage distance for outdoor terminations shall not be less than:

Adhesives used shall have a softening temperature of not less than 90° C, be compatible with other components and after curing shall not flow at temperatures of normal service.

1.1 kV, 1 IkV and 33kV joints and terminations shall be designed so that no insulating or semi-conducting tapes shall be required.Reinstallation of the insulation and semi - conducting cover shall be achieved with the use of multiple layers of heat shrinkable tubes possessing high dielectric strength and thermal stability.

Phase identification colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Project Manager may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Project Manager may determine.

All cables shall be identified and shall have phase colours marked at their termination.

14.2. CONNECTORS/TERMINALS

Connectors and terminals shall perform without distress under normal loading, cyclic loading and fault conditions, and shall not limit the rating of the cables which they joint.

33kV connections shall be compressed by hydraulically operated tools and 1 IkV/LV connectors by hand operated tools. The range of connectors/terminals should be kept to a minimum so as limit the the range of dies which may required and the use of die-less compression tools of the tension or non-tension type shall be permitted. Only approved and proven compression tools supplied by a reputable manufacturer shall be used.

The ends of connectors/terminals shall be suitably chamfered or coned to facilitate insertion of the conductors. Connectors shall have a solid central barrier to facilitate the insertion of the conductor to the correct depth.

The following items of information shall be clearly stamped on each connector/terminal:

- Manufacturer's name or trade mark.
- The conductor size (metric) for which the connector/terminal is suitable.
- The die number or size suitable for compressing the connector/terminal.

- The part of the connector/terminal surface to be compressed.
- The sequence of die action from the starting point and finishing point.

Compounds or greases for improving contact between the connector/terminal and the conductor are permitted. They must, however, be chemically neutral to the connector/terminal and conductor materials and must be present in position in the delivered connectors/terminals.

Cable connectors/terminals shall be able to accommodate typical variations in dimensions of cables supplied by different manufacturers.

Connector/terminal material shall not react chemically with the cable conductors to which they are connected.

Size and type of connectors required:

Straight through connectors for the following conductors:

- 300 - 300 mm^2 stranded round plain aluminium
- 185-185 mm^2 stranded round plain aluminium

- 120-120 stranded sector shaped plain aluminium Termination lugs for the following conductors:
- 300 mm^2 stranded round and sector shaped plain aluminium
- 185 mm^2 stranded round plain aluminium
- 150 mm^2 stranded sector shaped plain aluminium for the neutral of the 3.5 core 300 mm^2 cable.
- 120 mm^2 stranded round and sector shaped plain aluminium
- 70 mm^2 stranded round plain aluminium
- 50 mm^2 stranded round plain aluminium

Termination lugs shall be suitable for bi-metallic connections.

Terminals for pole top terminations of 33kV and 1 IkV cables shall be of the post type capable of accepting a tap off connector. Appropriate tap off connectors shall be provided for making connections from the cable to the line conductors.

14.3. CONTROL/LV WIRING ACCESSORIES 14.3.1. Terminations

Control wire terminations shall be made with solderless crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

LVAC cable terminals shall be provided with adequate size crimp type lugs.The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug in order to connect the gland to the earth bar.

PART 3 : GENERAL PARTICULARS AND GUARANTEES

15. COMPLIANCE WITH SPECIFICATION

The power and control cables shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of bidding in the Non Compliance Schedule in this document.

The mass and dimensions of any item of equipment shall not exceed the figures stated in the schedules.

16. COMPLIANCE WITH REGULATIONS

All the equipment shall comply in all respects with the Indian Regulations and Acts in force.

The equipment and connections shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

17. QUALITY ASSURANCE, INSPECTION AND TESTING

17.1. General

To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at any other place of work are in accordance with the Specification, with the regulations and with relevant authorised international or Indian Standards, the Contractor shall adopt suitable Quality Assurance Programmes and Procedures to ensure that all activities are being controlled as necessary.

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

The systems and procedures which the Contractor will use to ensure that the Plant complies with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works.The Contractor shall operate systems which implement the following:

Hold Point "A stage in the material procurement or workmanship process beyond which work shall not proceed without the documented approval of designated individuals or organisations."

The Project Manager's written approval is required to authorise work to progress beyond the Hold Points indicated in approved Quality Plans.

Notification Point "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Project Manager does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice then work may proceed.

17.2. Quality Assurance Programme

Unless the Contractor's Quality Assurance System has been audited and approved by the Project Manager, a Quality Assurance Programme for the Works shall be submitted to the Project Manager for approval a minimum of one month from contract award, or such other period as shall be agreed with the Project Manager. The Quality Assurance Programme shall give a description of the Quality System for the Works and shall, unless advised otherwise, include details of the following:

- The structure of the organisation;
- The duties and responsibilities assigned to staff ensuring quality of work;
- The system for purchasing, taking delivery and verification of materials;

- The system for ensuring quality of workmanship;
- The system for control of documentation;
- The system for the retention of records;
- The arrangements for the Contractor's internal auditing;
- A list of the administration and work procedures required to achieve and verify Contract's quality requirements. These procedures shall be made readily available to the Project Manager for inspection on request.

17.3. Quality Plans

The Contractor shall draw up for each section of the work Quality Plans which shall be submitted to the Project Manager for approval at least two weeks prior to the commencement of work on the

particular section. Each Quality Plan shall set out the activities in a logical sequence and, unless advised otherwise, shall include the following:

- An outline of the proposed work and programme sequence;
- The structure of the Contractor's organisation for the Contract;
- The duties and responsibilities assigned to staff ensuring quality of work for the Contract;
- Hold and Notification Points;
- Submission of engineering documents required by the specification;
- The inspection of materials and components on receipt;
- Reference to the Contractor's Work Procedures appropriate to each activity;
- Inspection during fabrication/construction;
- Final inspection and test.

17.4. Non-conforming product

The Project Manager shall retain responsibility for decisions regarding acceptance, modification or rejection of non-conforming items.

17.5. Sub-contractors

The Contractor shall ensure that the Quality Assurance requirements of this specification are followed by any sub-contractors appointed by him under the Contract.

The Contractor shall assess the sub-contractor's Quality Assurance arrangements prior to his appointment to ensure compliance with the appropriate ISO 9000 standard and the specification.

Auditing of the sub-contractor's Quality Assurance arrangements shall be carried out by the Contractor and recorded in such a manner that demonstrates to the Project Manager the extent of the audits and their effectiveness.

17.6. Inspection and testing

The Project Manager shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Project Manager without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.

The equipment shall successfully pass all the type tests, acceptance tests and routine tests referred to in the section on Tests and those listed in the most recent edition of the standards given in this specification.

The Project Manager reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall be carried out at an independent testing laboratory or be witnessed by a representative of such laboratory or some other representative acceptable to the Project Manager. Routine and acceptance tests shall be carried out by the Contractor at no extra charge at the manufacturer's works.

Type Test certificates shall be submitted with the bid for evaluation. The requirement for additional type tests will be at the discretion of the Project Manager.

The Project Manager may witness routine, acceptance and type tests. In order to facilitate this, the Contractor shall give the Project Manager a minimum of four weeks notice that the material is ready for testing. If the Project Manager does not indicate his intention to participate in the testing, the manufacturer may proceed with the tests and shall furnish the results thereof to the Project Manager.

Full details of the proposed methods of testing, including connection diagrams, shall be submitted to the Project Manager by the Contractor for approval, at least one month before testing.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Contractor, who shall provide the Project Manager with all the test facilities which the latter may require, free of charge. The Project Manager shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Contractor at an approved laboratory and shall be approved by the Project Manager.

The Contractor shall be responsible for the proper testing of the materials supplied by sub-contractors to the same extent as if the materials were completed or supplied by the Contractor.

Any cost incurred by the Project Manager in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or off-loading shall be to the account of the Contractor.

The Contractor shall submit to the Project Manager five signed copies of the test certificates, giving the results of the tests as required. No materials shall be dispatched until the test certificates have been received by the Project Manager and the Contractor has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, the Contractor shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

No inspection or lack of inspection or passing by the Project Manager's Representative of equipment or materials whether supplied by the Contractor or sub-contractor, shall relieve the Contractor from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

17.7. **Guarantee**

The Contractor shall guarantee the following :

- Quality and strength of materials used;
- Satisfactory operation during the guarantee period of one year from the date of commissioning, or 18 months from the date of acceptance of the equipment by the Project Manager following delivery, whichever is the earlier;
- Performance figures as supplied by the Bidder in the schedule of guaranteed particulars.

18. PROGRESS REPORTING

The Contractor shall submit for approval within four weeks of the starting date of the contract, an outline of production, inspection, delivery (and installation) in a chart form. Within a further period of four weeks, the Contractor shall provide a detailed programme of the same information in a form to be agreed by the Project Manager. The Contractor shall submit two copies of monthly progress reports not later than the 7th day of the following month. The reports shall show clearly and accurately the position of all activities associated with the material procurement, manufacture, works tests and transport, with regard to the agreed contract programme.

(The preferred format for presentation of programmes is MS Project Version 4.0. Programmes and monthly updates should be submitted on 3.5" diskettes.)

The design aspect of the progress report shall include a comprehensive statement on drawings, calculations and type test reports submitted for approval.

The position on material procurement shall give the dates and details of orders placed and indicate the delivery dates quoted by the manufacturer. If any delivery date has an adverse effect on the contract programme, the Contractor shall state the remedial action taken to ensure that delays do not occur.

The position on manufacture shall indicate the arrival of raw material and the progress of manufacture. Any events that may adversely affect completion in the manufacturer's works shall also be reported.

All works tests done shall be listed and test results shall be remarked upon. Any test failure shall be highlighted.

The dispatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.

Delays or test failures in any part of the programme which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

19. SPARE PARTS AND SPECIAL TOOLS

The Contractor shall provide prices for spare conductor, joints and termination equipment.

The Project Manager may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Project Manager may order additional spares at any time during the contract period at the rates stated in the Contract Document.

A spare parts catalogue with price list shall be provided for the various cables, joints and termination equipment and this shall form part of the drawings and literature to be supplied.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the installation and maintenance instructions.

20. PACKING AND SHIPPING

20.1. Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

- Individual serial number
- Employer's name
- Destination
- Contract Number
- Manufacturer's Name
- Year of Manufacture
- Cable Size and Type
- Length of Conductor (metres)
- Net and Gross Mass of Conductor (kg)
- All necessary slinging and stacking instructions.
- Destination;
- Contractor's name;
- Name and address of Contractor's agent in Orissa;
- Country of origin;

The direction of rolling as indicated by an arrow shall be marked on a flange.

20.2. Storage

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

20.3. Shipping

The Contractor shall be responsible for the shipping of all cables, drums and reels supplied from abroad to the ports of entry and for the transport of all goods to the various specified destinations including customs clearance, offloading, warehousing and insurance.

The Contractor shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Contractor shall also be responsible for verifying the access facilities specified.

The Contractor shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Contractor shall immediately report to the Project Manager any claims made against the Contractor arising out of alleged damage to a highway or bridge.

All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations (work sites.)

The Contractor shall advise the storage requirements for any plant and equipment that may be delivered to the Project Manager's stores. The Contractor shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behaviour of the equipment in subsequent service.

20.4. Hazardous substances

The Contractor shall submit safety data sheets in a form to be agreed for all hazardous substances used with the equipment. The Contractor shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. The Contractor shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Contractor shall be responsible for any injuries resulting from hazardous substances due to non compliance with these requirements.

21. SUBMITTALS

21.1. Submittals required with the bid

The following shall be required in duplicate :

- completed technical data schedule;
- descriptive literature giving full technical details of equipment offered;
- type test certificates, where available, and sample routine test reports;
- detailed reference list of customers already using equipment offered during the last 5 years with particular emphasis on units of similar design and rating;
- details of manufacturer's quality assurance standards and programme and ISO 9000 series or equivalent national certification;
- deviations from this specification. Only deviations approved in writing before award of contract shall be accepted;

21.2. Submittals required after contract award

21.2.1. Programme Five copies of the programme for production and testing.

21.2.2. Technical particulars

Within 30 days of contract award five bound folders with records of the technical particulars relating to the equipment. Each folder shall contain the following informatio

- general description of the equipment and all components, including brochures;
- technical data schedule, with approved revisions;
- calculations to substantiate choice of electrical and mechanical component size/ratings;
- statement drawing attention to all exposed points in the equipment at which copper, aluminium or aluminium alloy parts are in contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point;
- detailed installation and commissioning instructions;

At the final hold point for Project Manager approval prior to delivery of the equipment the following shall be submitted:

- inspection and test reports carried out in the manufacturer's works;

- Installation and maintenance instructions. 21.2.3. Operation and maintenance instructions

A copy of the detailed installation and commissioning instructions shall be supplied with each type cable joint and termination equipment.

21.3. Drawings

Within 30 days of contract commencement the Contractor shall submit, for approval by the Project Manager, a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a programme of drawing submission, for approval by the Project Manager, that ensures that all drawings and calculations are submitted within the period specified above.

All detail drawings submitted for approval shall be to scale not less than 1:20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings. All documents and drawings shall be submitted in accordance with the provisions of this specification and shall become the property of the Employer.

All drawings and calculations submitted to the Project Manager shall be on international standard size paper, AO, Al, A2, A3, or A4. All such drawings and calculations shall be provided with a contract title block, which shall include the name of the Employer and Consultants and shall be assigned a unique project drawing number. The contract title block and project numbering system shall be agreed with the Project Manager.

Lettering sizes and thickness of lettering and lines shall be selected so that if reduced by two stages to one quarter of their size, the alphanumeric characters and lines are still perfectly legible so as to enable them to be microfilmed.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

22. APPROVAL PROCEDURE

The Contractor shall submit all drawings, documents and type test reports for approval in sufficient time to permit modifications to be made if such are deemed necessary and re-submit them for approval without delaying the initial deliveries or completion of the contract work. The Project Manager's representative shall endeavour to return them within a period of four weeks from the date of receipt.

Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Project Manager reserves the right to request any further additional information that may be considered necessary in order to fully review the drawings. If the Project Manager is satisfied with

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the drawing, one copy will be returned to the Contractor marked with "Approved" stamp. If the Project Manager is not totally satisfied with the drawing, then "Approved Subject to Comment" status will be given to it and a comment sheet will be sent to the Contractor. If the drawing submitted does not comply with the requirements of the specification then it will be given "Not Approved" status and a comment sheet will be sent to the Contractor. In both these cases the Contractor will have to modify the drawing, update the revision column and resubmit for final Approval. Following approval, twenty copies of the final drawings will be required by the Project Manager.

Any drawing or document submitted for information only should be indicated as such by the Contractor. Drawings and documents submitted for information only will not be returned to the Contractor unless the Project Manager considers that such drawing needs to be approved, in which case they will be returned suitably stamped with comments.

The Contractor shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Project Manager. Approval given by the Project Manager to any drawing shall not relieve the Contractor from his liability to complete contract works in accordance with this specification and the condition of contract nor exonerate him from any of his guarantees.

If the Contractor needs approval of any drawing within a period of less than four weeks in order to avoid delay in the completion of supply, he shall advise the Project Manager when submitting the drawings and provide an explanation of the document's late submission. The Project Manager will endeavour to comply with the Contractors timescale, but this cannot be guaranteed.

23. SURFACE TREATMENT

Where galvanised steel armour wire is used then the Contractor shall indicate his galvanising process utilised and its conformance with this specification

23.1. Galvanising

All galvanising shall be carried out by the hot dip process, in accordance with Specification ISO 1460 or IS 2629. However, high tensile steel nuts, bolts and spring washers shall be electro galvanised to Service Condition 4. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paint, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanising shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard BS 729, ISO 1460 or IS 2629 and shall be not less than 0.61kg/m2 with a minimum thickness of 86 microns for items of thickness more than 5mm, 0.46 kg/m^ (64 microns) for items of thickness between 2mm and 5mm and 0.33 kg/m2 (47 microns) for items less than 2mm thick.

Parts shall not be galvanised if their shapes are such that the pickling solution cannot be removed with certainty or if galvanising would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanised unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanising the method used for repair shall be subject to the approval of the Project Manager or that of his representative.

Repair of galvanising on site will generally not be permitted.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Project Manager. All nuts shall be galvanised. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. To avoid the formation of white rust, galvanised material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to test as per IS-2633.

24. COMPLETENESS OF CONTRACT

All fittings or accessories, although not specifically mentioned herein, but necessary or usual for similar equipment and their efficient performance shall be provided by the Contractor without extra charges. The bid shall clearly indicate if any additional equipment or parts would be necessary to give a complete offer and if so, the details and the prices shall be included in the bid.

MORE INFORMATION ON POWER & CONTROL CABLES [FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1 Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for colony lighting from control room.

1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switch yard area/control room except for control/protection purposes.

1.3 For all control/protection/instrumentation purposes PVC insulated control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.
The sizes of power cables to be used per feeder in different application shall be as applicable, described here under.

1.5 Bidder may offer sizes other than the sizes specified in clause 1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval.

1.6. Cables shall be laid conforming to IS : 1255.

1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.7.1 Separate cables shall be used for AC & DC.

1.7.2 Separate cables shall be used for DC1 & DC2.

1.8 For different cores of CT & CVT separate cable, core wise shall be used .The minimum sizes of the conductor for each terminal shall be 2X2.5 sqmm.

1.9 For control cabling, including protection circuits, minimum 2.5 sq.mm. size copper cables shall be used per connection.

TECHNICAL REQUIREMENTS

2. General

2.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

2. 2 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

2.3 The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

2.4 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

2.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

2.6 Progressive sequential marking of the length of cable in metres at every one meter shall be provided on the outer sheath of all cables.

2.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS : 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

2.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

2.9 All the cables shall pass fire resistance test as per IS:1554 (Part-I)

2.10 The normal current rating of all PVC insulated cables shall be as per IS:3961.

2.11 Repaired cables shall not be accepted.

3. **XLPE Power Cables**

3.1 The XLPE **(90°C**) insulated cables shall be of FR type, C1 category conforming to IS:7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables.

4. **PVC Power Cables**

4.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.

5. **PVC Control Cables**

5.1 The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour .

6. HV POWER CABLES [FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV]

6.1. *HV* POWER CABLE FOR AUXILIARY POWER SUPPLY

The HV cable of voltage class as specified for LT transformer shall be, XLPE insulated, armoured cable conforming to IS 7098 (Part-II) or IEC 60502-2 1998. Terminating accessories shall conform to IS 17573-1992 or IEC 614421997/IEC60502-4 1998.

6.2. Constructional Requirements

Cable shall have compacted circular Aluminium conductor, Conductor screened with extruded semi conducting compound , XLPE insulated, insulation screened with extruded semi conducting compound, armoured with non-magnetic material, followed by extruded PVC outer sheath(Type ST-2), with FR properties ***.***

*6.*3 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.

6.4 The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.

7. TYPE TESTS

7.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

THE SIZES OF POWER CABLES TO BE USED PER FEEDER IN DIFFERENT APPLICATION SHALL BE AS APPLICABLE, DESCRIBED HERE UNDER.

S.No.	From	To	Cable size	Cable type
1.	Main Board Switch	LT Transformer	2-1C X 630 mm^2 per phase 1-1C X 630 mm^2 for neutral	XLPE
2.	Main Board Switch	AC Distribution Board	2-3½C X 300 mm^2	XLPE
3.	Main Board Switch	Oil Filtration Unit	1-3½C X 300 mm^2	XLPE
4.	Main Board Switch	Colony Lighting	1-3½C X 300 mm^2	XLPE
5.	Main Board Switch	HVW pump LCP	1-3½C X 300 mm^2	XLPE
6.	Main Board Switch	Main Lighting distribution board	1-3½C X 300 mm^2	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	2-3½C X 300 mm^2	PVC
8	AC Distribution Board	Emergency Lighting distribution board	1-3½C X 70 mm^2	PVC
9	AC Distribution Board	ICT MB	1-3½C X 70 mm^2	PVC
10	AC Distribution Board	Bay MB	1-3½C X 70 mm^2	PVC
11	Bay MB	AC Kiosk	1- 3 ½ x 35 mm^2	PVC
12	AC Distribution Board	Battery Charger	1-3½C X 70 mm^2	PVC
13	DCDB	Battery	2-1C X 150 mm^2	PVC
14	DCDB	Battery Charger	2-1C X 150 mm^2	PVC
15	DCDB	Protection/PLCC panel	1-4C X 16 mm^2	PVC
16	Main Lighting DB	Lighting	1-3½C X 35 mm^2	PVC

		panels(Indoor)		
17	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm^2	PVC
18	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm^2	PVC
19	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm^2	PVC
20	Lighting Panel	Sub lighting panels	1-4C X 16 mm^2	PVC
21	Lighting Panel	Street Lighting Poles	1-4C X 16 mm^2	PVC
22	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	1-2C X 6 mm^2	PVC

PART 4: SCHEDULES

25. TECHNICAL DATA SCHEDULES

3. 1100V Cable Schedule

Remarks:- a) All the LV Power Cable shall be XLPE with insulated armoured Aluminum Cable.

b) All the Control Cable shall be PVC insulated Cables.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

SUB STATION LIGHTING

SUBSTATION LIGHTING

TABLE OF CONTENTS

1. GENERAL

The scope comprises design, engineering, supply, installation, testing and commissioning of the following:

- Complete installation and lighting fixtures complete with lamps, supports and accessories;For indoor and outdoor
- Ceiling fans complete with electronic regulators, accessories;
- lighting panels and lighting poles complete with distribution boxes;
- Galvanised rigid steel conduits and fittings, lighting PVC ables GI Earth wire receptacles, switchboards, switches, junction boxes, pull out boxes complete with accessories;
- Lighting transformer.
- Any other items required to complete the indoor and outdoor lighting in complete shape.

The details of area to be illuminated are given in Table 1. along with the required lux levels.

Area	Lux
Control Room	350
PLCC Room	300
LT Room	150
Charger Room	150
Cable Gallery	150
Heating Plant	100
Battery Room	100
Computer Room	300
Entrance lobby	150
Corridor and landing	150
Conference and display	300
Rest Room	250
AHU Room	100
DG Set Building	150
Fire Fighting Pump House	150
Switchyard - Main equipment	50
Switchyard - general equipment and balance	30
Street/Road	30

Table 1. Areas to be lit and required lux levels

Contractor shall submit detailed calculation for verifying that the required lux levels will be attained by the proposed lighting system

Any material, cables, wire, conduits, fittings, accessories etc. whether mentioned specifically or not but required for installation of lighting fixtures are included in the scope of Contractor.

1. SYSTEM DESCRIPTION

1.1 Normal lighting - AC

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards to be supplied.

1.2 Emergency lighting - AC

This system will be available in control room building, switchyard and diesel generator building. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency.

1.3 Emergency lighting - DC

DC emergency lighting fixtures operated from the DC system shall be provided in strategic locations so that the operating personnel can safely find their way during a total AC failure. These lights will be normally **'OFF'** and will be switched **'ON'** automatically when under voltage occurs in the AC mains lighting distribution board.

1.4 Emergency lighting - portable

Emergency portable light shall be provided as per relevant clause of this section. Three portable lights for control room and two portable lights for PLCC room shall be provided for every substation.

1.5 Temperature Rise

All lighting fixtures and accessories shall be designed to have a low temperature rise according to IEC 598 Part-I/ IS 10322 (Part-4).Temperature rise of panels should be as per IS 8623 (Part-l)/IEC 439-1.

2. LIGHTING FIXTURES

2.1 General

Fixture shall conform to latest IS / IEC .and its latest amendment.

All 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.

All lighting fixtures shall be complete with required lamps such as LED (to be fitted inside switch yard and all street light), & LED light (adopt as per Govt nerms for energy efficiency) for indoor lighting..

LED lamp fixtures shall be complete with all necessary wiring and accessories such as ballasts, ignitors, power factor improvement capacitors etc if required. These shall be mounted in the fitting assembly only. The Contractor shall indicate starting time of these lamps to attain full light output. Curves for starting characteristics with varying supply voltage etc. are to be furnished by the Contractor.

Flood lighting shall have suitable base plate/frame for mounting on structural steel member.

Each fixture (other than bulk head fixtures) shall have terminal blocks suitable for 2.5 mm^2 stranded flexible copper conductor. The internal wiring should be completed by the manufacturer and terminated on the above terminal blocks. The Contractor shall specifically furnish details of internal size of wires and type of insulation. The terminal blocks shall be as specified under General Equipment and Substation Accessories (GESA) section of this Specification.

Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

All metal or metal enclosed parts of the housing shall be suitably constructed so as to ensure satisfactory earthing continuity throughout the fixture up to the earthing terminal.

The mounting facility and conduit knock-outs for the fixtures shall be provided and shall be suitable for 20 mm conduit entry.

On completion of manufacture, all surfaces of the fixtures shall be thoroughly cleaned and degreased. The fixtures shall be free from scale, rust, sharp edges and burrs.

The housing shall be stove-enamelled or vitreous enamelled or anodised aluminium as indicated in the specification of the relevant fixture.

All enamel finishing shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 degrees. over 1.5 inch die mandrel.

All light reflecting surfaces shall have optimum light reflecting coefficient so as to ensure the overall light output as specified.

The different types of lighting fixtures to be provided shall be to the approval of the OPTCL.

REMARKS: ALL THE LAMPS TO BE USED INSIDE & OUTSIDE THE SUB-STATION AREA SHALL BE OF "LED" ONLY. BIDDERS ARE ADVISED TO QUOTE ACCORDINGLY.

2.2 Accessories

2.2.1 Reflectors

The reflectors shall be manufactured from sheet steel or aluminium more applicable of not less than 22 SWG thickness. They shall be securely fixed and of captive type.

2.2.2 Lamp holders

Lamp holders shall preferably be for LED lamps etc.. Holders shall be designed and manufactured in accordance with relevant standard to give long and satisfactory service.

2.2.3 Ballasts(if required)

Ballasts shall be designed, manufactured and supplied in accordance with IS 3021 and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life. The power loss in ballasts (if required)for LED lamps shall not be more than the specified watts as per relevant standard and for the fluorescent lamps it shall be the minimum commercially available in the industry.

Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

The ballasts shall be of the inductive, heavy duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. Ballasts shall be designed for maximum winding temperature rise of 55C under rated conditions. They shall be free from hum. Ballasts for LED lamps shall be provided with suitable tapping to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.

Separate ballasts for each lamp shall be provided in case of multi-lamp fixtures.

The Contractor shall submit general arrangement and wiring diagram with all terminal details for approval of the OPTCL.

2.2.4 Capacitors

Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

Capacitors shall be suitable for operation at the supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.

Capacitors shall be hermetically sealed in a metal enclosure.

2.2.5 Lamps

The LED lamps to be supplied shall conform to IS 9974. LED lamps shall be suitable for use in any position. Restrictions, if any, shall be clearly stated. The lamps shall be capable of withstanding small vibrations with out breakage of connections at lead-in wires and filament electrodes.

The constructional features of LED lamps for special applications shall be clearly brought out in the bid.

The Bidder shall furnish typical wiring diagrams for all fittings including all accessories. The diagrams shall include technical details of accessories i.e. ignitors, ballasts, capacitors etc.

2.3 Receptacles

All receptacles shall be of cast steel or aluminium, heavy duty type, suitable for fixing on wall or column and complete with individual switch.

In general the receptacles to be installed are of the following types:

- Type RO-15A, 240V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2 core 6 mm^2 PVC armoured cable and a metallic cover fixed to it with a metallic chain. Receptacles shall be suitable for installation in moist location and/ or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick GI sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gaskets. This shall conform to IP 55.

- Type RI-Combination of 5A and 15A, 240V, 3 pin type with third pin grounded, suitable for flush mounting. The switch shall be of piano key type and shall be flush mounted.

- Type RP-63A, 415V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3½ core 35mm^2 / 3½ core 70mm^2 aluminium conductor cable entry and shall also be suitable for loop-in-loop-out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2 mm thick G. I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gaskets. This shall conform to IP 55.

3. LIGHTING POLES

The Contractor shall supply, the following types of hot dip galvanised steel tubular lighting poles required for street lighting:

a) Type Al street lighting pole - for one fixture

b) Type El post top lantern pole - for one fixture

Street/flood light poles shall conform to the drawings approved by the OPTCL.

Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted above ground level at 1 mtr height from the ground.

The lighting poles shall be steel hot dip galvanised

The galvanised sheet steel junction box for the street lighting poles shall be completely weather proof conforming to IP 55 and provided with a lockable door and HRC fuse mounted on a fuse carrier and

fuse base assembly. The terminals shall be stud type and suitable for two nos. 16mm^2 cables. Necessary arrangement for cable glands along with supply of double compression glands are included in Contractor's scope.

Wiring from junction box at the bottom of the pole (minimum height from the bottom of the pole shall be 1.0mtrs) to the fixture at the top of the pole shall be 2.5 mm^2 wire.

4. LIGHTING WIRES & CABLES

The wiring used for lighting shall be of 1100V grade, PVC insulated cable of standard products of reputed manufacturers.

The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4 mm^2, 6mm^2 and 10mm^2 stranded aluminium wires and 2.5 mm^2 stranded copper wire.

The wires used for connection of a lighting fixture from area rest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IS 694 with nominal conductor cross sectional areas of 2.5mm^2.

The Contractor's scope covers supply of all wiring, cabling and accessories.

The wires shall be colour coded as follows:

- Red for R - Phase
- Yellow for Y - Phase
- Blue for B - Phase
- Black for Neutral
- White for DC (Positive)
- Grey for DC (Negative)

5. TESTS AND TEST REPORTS

Type tests, acceptance tests and routine tests for the lighting fixtures and accessories covered by this specification shall be carried out as per the relevant standard for the respective fixtures and their accessories.

Manufacturer's type and routine test certificates shall be submitted for the fixtures and accessories. Type test certificates shall be furnished along with the bid.

Rates for type tests for all types of fixtures and accessories for light fittings as required under relevant section of this specification shall be provided in the relevant price schedules.

6. LIGHTING SYSTEM INSTALLATION WORKS

6.1 General

In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Project Manager. Contractor shall supply, erect, install, test and put into commercial use all the electrical lighting equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in manufacturer's drawings or as stipulated by Project Manager.

The Contractor shall prepare the lighting layout and erection drawings and obtain the Project Manager's approval before commencing the erection works.

6.2 Flood lights.

Contractor shall install flood lights on switchyard structures to be erected inside switchyard. The GI structural are also suitable for protection from lightening by providing spikes cones at all the column peak. Proper design in this respect to be carried out along with numbers of such towers required. Plotting of lightening protection area showing details of equipment installed in switch yard. A platform provided in the mast tower shall be used for fixing of lighting fixtures.

Fixtures shall be mounted on galvanised making use of shop provided holes or by suitable clamps. No cutting or drilling of galvanised structure is permitted.

The Contractor shall mount the assembled fittings and install necessary cabling.

6.3 Lighting fixtures for flood lights

Flood lights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture by approximately 5 degrees on both sides. Bolts shall be finally tightened with spring washer. The Contractor shall supply and install the steel base, channels, angles etc. for fixing the flood light on the flood light towers. Terminal connection to the flood light shall be through flexible conduits, and these flexible conduits shall be included in the installation rate of fixture itself.

The scope of Contractor shall include the supply of necessary brackets and sundry material, for installation of lighting fixtures.

6.4 Lighting panels

Lighting panels shall be erected at the locations to be indicated in the approved drawings.

Necessary foundations and/or supporting structures for all outdoor type lighting panels and necessary supporting structures for indoor lighting panels shall be provided by the Contractor.

6.5 Street lighting poles

Street lighting poles shall be installed as per the approved drawings.

Steel tubular hot dip galvanised pole,s which are specified for the above purpose are to be installed as per the approved lay out for street lighting system. Contractor shall erect the poles (including foundation works), mount the assembled fittings and install necessary cabling.

7. TECHNICAL PARAMETERS OF LIGHTING TRANSFORMERS

i)	Type of transformer	Dry type natural air
ii)	Rating	1 00 kVA or 75kVA
iii)	Voltage ratio	415/415 volts
iv)	No. of phase	Three
v)	Frequency	50Hz
vi)	Winding connection	Dyn 1
vii)	Class of insulation	B class
viii)	Percentage Impedance	4%, ±10%
ix)	No. of taps and steps	5 in steps of 2.5%
x)	Reference standard	IS 2026
xi)	Any latest amendment standards of the above.	

Transformers shall be located in ACDB room, in separate enclosure. Enclosure shall have degree of protection not less than IP 42 as per IS 2147.

8. EMERGENCY PORTABLE LIGHTING FIXTURES

The portable emergency lighting fixtures supplied shall have a built in battery rated for six hours and be complete with battery chargers and solid state inverters, and be supplied with all necessary supporting brackets of galvanised steel suitable for wall/column mounting..

The portable emergency lighting fixtures shall be of a single unit, completely tropicalised, suitable for prolonged use with no maintenance, and shall light up automatically in the event of failure of normal supply.

The Contractor shall submit schematic along with all details and general arrangement drawing for approval.

9. CEILING FANS AND REGULATORS

The Contractor shall supply 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories.

The Contractor shall supply the switch, electronic regulator and board for mounting switch and electronic regulator.

Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

Electronic regulator with smooth control shall be provided.

Precautions shall be taken in manufacture of fans and regulators to ensure reasonable degree of silence at all speeds.

Type tests, acceptance tests and routine tests for the fans and regulators shall be carried out as per latest relevant standard.

Fans and electronic regulators shall be from established manufacturers or brands.

10. FOUNDATION AND CIVIL WORKS

All foundations and civil works shall be included in the Contractor's scope of work. Civil works shall be in accordance with the relevant part of this specification.

11. GROUNDING

All lighting panels, junction boxes, fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. Rules.

Ground connections shall be made from nearest available station ground grid. All connections to ground grid shall be done by arc welding.

Lighting panels shall be directly connected to ground grid by two 50 x 6mm G.S. flats.

A continuous ground conductor of 16 SWG GI wire shall be connected to each panel ground bus. All junction boxes, lighting fixtures shall be connected to this 16 SWG ground conductor.

All lighting poles shall be earthed as per standard. 16 SWG GI wire shall be taken up to junction box from the lighting fixture.

12. TESTING AND COMMISSIONING

On completion of erection work, the Contractor shall request the OPTCL to undertake the inspection as required by this Specification.

The OPTCL 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 tested and commissioned in the presence of the Contractor and OPTCL

The Contractor shall provide all men, material and equipment required to carry out the tests.

All rectification, repairs or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor, without any extra cost to the Employer.

The Contractor shall measure and furnish to the Project Manager, the actual lux level in all the areas of the substation to prove compliance to this specification.

**** Armoured PVC cables are to be used for the switch yard lighting, street lighting and any other out door lighting system.**

**** For indoor lighting ,each fixture shall be controlled by one switch.**

**** Minimum two nos 5 Amp multi purpose power sockets with switch are to be provided in each switch.**

***** Contractor to furnish the design details for the locations (like Switch yard area,Road street light,Control room building area,Quarter ,Gate etc), which can be adopted after approval from OPTCL. Design to be carried out as per the LUX level indicated at the beginning of this chapter.**

TECHNICAL SPECIFICATION FOR LED FLOOD / NORMAL LIGHT FITTINGS 1 PH A.C OPERATION

1.GENERAL DESCRIPTION

LED Flood/Normal Light luminaries of 240V, A.C,50 Hz ,suitably decided the wattage of the lamp (to be decided after detail Engineering) in Single piece High Pressure Die Cast Aluminium alloy Housing having high conductivity acting as heat sink, with Powder coating with suitable colour with distortion free, clear, Heat Resistant Toughened UV stabilized Glass in the front fixed to the die cast Aluminium frame which shall be fixed to the housing with high quality long lasting Neoprine Rubber gasket duly impregnated with insecticide and water repellant chemical on the periphery of lamp compartment by means of stainless steel screws to render it dust proof, water proof and vermin proof and having minimum IP-65 Protection conforming to IS:10322 (part-2) – 1982.

Note: The capacity LED Luminary is to be suitably decided after conducting the detail Engineering for the locations , where these Luminaries are to be used. The Locations are generally in EHV grade Sub-station switch yard area,Street Lighting, Control Room Building, Colony Quarters etc. Details design for adoption of LED Luminary system to be furnished for review of design and its acceptance. Latest practice of adoption of these system are to be strictly followed.

2. TRAINING :

Train the staff on Hardware /Software ,installation, commissioning and maintenance of the Luminaries at different locations (Different Sub-stations).

3. TECHNICAL SPECIFICATIONS:

The LED Luminaries are as per the following parameters

a	**Mid Power White LED's**	Should be of reputed make as indicated in the Tender specification.
b	Wattage of Mid Power White LED,s offered	Low power LED 5252 0.3W
c	LED Lumens	
d	Life span as per LM70(@70%) light output	>50000 Hrs. 0r Better
	Lux at centre at height of 4.5 meter	>150 LUX 0r Better
e	Uniformity Ratio(Emin./Emax.)(mounted at 4.5m height @90 ˚Angle)	>0.35 0r Better
f	Luminary Efficacy	>65 0r Better
g	Control of Distribution	Fully Cutoff
i	Driver current(With Constant Current Driver)	<100mA/LED 0r Better
j	**Electronic** Efficiency@230V	**>85% 0r Better**
k	Beam angle of the Luminary	> 120° 0r Better
l	color Temperature of LEDs	6500K to 7500K 0r Better

m	P/N junction temperature (High thermal conduction must be achieved by silicon heat conducting greases as adhesive	<85 ºC 0r Better
n	Luminary Body Temperature	The Body Temperature shall be <(Ambient+35º C) even after continuous burning of Luminary for 24 Hrs.**0r Better**
o	color Rendering Index(CRI)	>70 **0r Better**
p	weight	Preferably less weight & may be of Maximum up to 4 Kgs (comfortably can be carried and fixed)
B	**ELECTRICAL**	
a	AC Input Voltage Range	100V TO 270V AC
b	AC Input frequency .(The LED circuitry shall function at an operating frequency that must be greater than 120 Hz to prevent perceptible flicker to the unaided eye over the entire voltage range specified above.)	47 ~ 53Hz
c	Power Factor (Source Power Factor varies from 0.5 Lag to 0.5 Lead)	> 0.95 **0r Better**
d	Luminary Wattage variance at 100 V to 270 V	± 10%
e	Luminary Lux Levels Variance at 100 V to 270 V	± 5%
f	Total Harmonic Distortion(THD)	< 15% **0r Better**
g	Electrical Connection System	3 wire system (Phase,Neutral & Gnd)
h	System of earthing (The luminaries offered shall conform to Level-1 classification)	Solidly grounded
i	There shall be electrical isolation between input and output circuits	
C	**MECHANICAL**	
a	Construction of Casing	High Pressure Die Cast Aluminum. Should be durable for extreme climatic conditions.
b	Finish	Powder Coating and gray/black color and should be durable. The colour should not fade in extreme climate conditions.

c	Heat Sink type (It shall be designed in such a way that the heat generated within the LED source is efficiently dissipated to the surrounding atmosphere without abnormal rise in temperature. Any debris build up shall not degrade heat dissipation performance of the luminaries.	Aluminium Metal Core PCB
d	Lamp Cover	Toughened Glass or any suitable material which can be used in the extreme climate and should be durable.
e	Gross Weight and Dimensions (L x W x T) mm of Luminaries (Efforts shall be made to keep the overall outer dimensions as minimum as possible with out compromising on the performance, mainly thermal management of the luminary)	
f	Heat Dissipating Area (Luminary Rating wise)	
g	IP Level –Minimum IP 65	

18W AC DOWN LIGHT

DATASHEET

Applications :

Area: Indoor
Purpose: Home and Office Lighting.

Features:

(1) Optical

- » Optical pattern meets all standard Home and Office Light Standards.
- » Uniform illuminance distribution.

(2) Power

- » Switched mode constant current power supply.
- » Over-heat, Over-voltage, Over-current protections are provided.
- » Lightning Protection provided.

(3) Thermal

» Luminaire surface temperature is 48°C @ Ta=30°C, the temperature variation is controlled under 5°C.
» Junction temperature is controlled ot 70°C @ Ta=30.
» Overheat protection will operate to adjust as the LED module surface reaches 80°C.

(4) Luminaire

» Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
» Dust and water protection design meeting IP65 standards.
» Super-high luminaire efficacy.

DETAILED TECHNICAL SPECIFICATION

Electrical Characteristics:

PARAMETER	DRIVER RESULT
Input Voltage	160 -300 V AC
Rated Power	18Watt
Maximum Power	21Watt
Efficiency	>85%
Power Factor	>0.9
Voltage Harmonics (THD)	<5%
Current Harmonics (THD)	<10%

Operating Conditions:

Operating Frequency	100kHz to 200KHz
Operating Temperature Range	-25°C to +70°C
Storage Temperature Range	-65°C to 125°C
Humidity	95% RH

LED Details:

Led Make	As per approved vendor
No Of LED's	12
Led Viewing Angle	120º by using reflector
Colour Temperature	Cool White (5500 to 6500K)
Luminous Flux	>2160 Lumens
Life Span	> 80,000 Hours
Colour Rendering Index	>70 Ra

LED Luminary Details:

Body	Alluminium Body
Heat Sink	Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
Dust and Water protection	IP 65 Standards

Protection Parameters:

Over-Current Protection	Inbuilt
Short-Circuit Protection	Inbuilt
Over-Voltage Protection	Inbuilt
Over-Temperature Protection	135 °C
Dust and Water Protection	IP 65
Lightning Protection	Inbuilt

50W AC LOW BAY LIGHT

LED bay light fixture is designed and developed to replace traditional high bay or low bay fixtures for industrial and other rugged applications. Light weighted and easy for installation, the LED High Bay/Low Bay fixtures are all designed to offer maximum energy saving, substantially reduced maintenance costs and superior quality.

Major Applications :

Factory production floors, Workshop, Warehouses, Road toll gates, Petrol stations, Supermarkets, Sports stadiums, Convention center halls, Airport passenger halls, etc., where high ceiling lighting required.

Features :

1)Low power consumption. More than 60% energy saving compared to conventional HID/HPS.
2) Environmental friendly. Lead and mercury free. Long operation life time, above 50,000hours. Low maintenance costs.
3)Voltage input 160-300 V AC,
4)Instant ON/OFF operation.
5)Superior color rendition compared to conventional industrial luminaries.
6)Selectable color temperature.
7)Single piece 30W-100W high power LED light source with unique multi-chip integration design ensure high light purity, high heat conduction and slow brightness derating.

8)Unique heat sink design ensures superior heat management.
9)Resistant to shock and vibration.

Specifications :

Input Voltage	AC 160-300V
Power Frequency of Driver	47～63Hz
Power Efficiency of Driver	≥85%
LED Power Consumption	50w
Power Factor(PF)	≥0.90
Total Harmonic Distortion	≤10%
Luminaries Efficiency	≥90%
Flux (Lumens)	4000
Color Rendering Index	≥80
Color Temperature	2700～7000K Optional
Beam Angle	90/120 Degree Optional
Light Effect	70～80lm/W
Working Ambient Humidity	-25℃～+45℃
Working Ambient Humidity	15%～90%RH
IP Rating	IP30/IP54 Optional
Service Life	≥50000 Hours
Light Fixture Material	Aluminum Alloy

100W AC LED STREET LIGHT

DATASHEET
Applications :
Area: Outdoor
Purpose: Street and Roadway Lighting.

Features:
(1) Optical
- » Optical pattern meets all standard Street Light Standards.
- » Uniform illuminance distribution.

(2) Power
- » Switched mode constant current power supply.
- » Over-heat, Over-voltage, Over-current protections are provided.

» Lightning Protection provided.

(3) Thermal

» Luminaries surface temperature is 48°C @ Ta=30°C, the temperature variation is controlled under 5°C.

» Junction temperature is controlled ot 70°C @ Ta=30.

» Overheat protection will operate to adjust as the LED module surface reaches 80°C.

(4) Luminaire

» Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.

» Dust and water protection design meeting IP65 standards.

» Super-high luminaire efficacy.

DETAILED TECHNICAL SPECIFICATION

Electrical Charatcteristics

PARAMETER	PROMPT DRIVER RESULT
Input Voltage	160 -300 VAC
Rated Power	100W
Maximum Power	115W
Efficiency	>85%
Power Factor	>0.9
Voltage Harmonics (THD)	<5%
Current Harmonics (THD)	<10%

Operating Conditions:

Operating Frequency	100kHz to 200KHz
Operating Temperature Range	-25°C to +70°C
Storage Temperature Range	-65°C to 125°C
Humidity	95% RH

LED Details:

Led Make	As per approved vendor
No of LED's	48-70
Led Viewing Angle	120º by using reflector
Colour Temperature	Cool White (5500 to 6500K)
Luminous Flux	>8500 Lumens
Life Span	> 50,000 Hours
Colour Rendering Index	>70 Ra

LED Luminary Details:

Body	Alluminium Die casting Body
Heat Sink	Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
Protection	IP 65 Standards for Dust and Water

Protection Parameters:

Over-Current Protection	Inbuilt
Short-Circuit Protection	Inbuilt
Over-Voltage Protection	Inbuilt
Over-Temperature Protection	135 °C
Dust and Water Protection	IP 65
Lightning Protection	Inbuilt

120/150W AC LED FLOOD LIGHT

DATASHEET
Applications :
Area: Outdoor
Purpose: Street and Roadway And Area Lighting.

Features:

(1) Optical
- » Optical pattern meets all standard Street Light Standards.
- » Uniform illuminance distribution.

(2) Power
- » Switched mode constant current power supply.
- » Over-heat, Over-voltage, Over-current protections are provided.
- » Lightning Protection provided.

(3) Thermal
- » Luminaries surface temperature is 48°C @ Ta=30°C, the temperature variation is controlled under 5°C.
- » Junction temperature is controlled ot 70°C @ Ta=30.
- » Overheat protection will operate to adjust as the LED module surface reaches 80°C.

(4) Luminaire
- » Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
- » Dust and water protection design meeting IP65 standards.
- » Super-high luminaire efficacy.

DETAILED TECHNICAL SPECIFICATION

Electrical Charatcteristics

PARAMETER	PROMPT DRIVER RESULT
Input Voltage	160 -300 VAC
Rated Power	120W
Maximum Power	140W
Efficiency	>85%
Power Factor	>0.9
Voltage Harmonics (THD)	<5%
Current Harmonics (THD)	<10%

Operating Conditions:

Operating Frequency	100kHz to 200KHz
Operating Temperature Range	-25°C to +70°C
Storage Temperature Range	-65°C to 125°C
Humidity	95% RH

LED Details:

Led Make	As per approved vendor
No of LED's	48-70
Led Viewing Angle	120º by using reflector
Colour Temperature	Cool White (5500 to 6500K)
Luminous Flux	>8500 Lumens
Life Span	> 50,000 Hours
Colour Rendering Index	>70 Ra

LED Luminary Details:

Body	Alluminium Die casting Body
Heat Sink	Optimized thermal design to ensure maximum life to LED. The Heat sink grade aluminium has the highest surface area for efficient heat diffusion and the entire luminary with Aluminium acts as heat sink.
Protection	IP 65 Standards for Dust and Water

Protection Parameters:

Over-Current Protection	Inbuilt
Short-Circuit Protection	Inbuilt
Over-Voltage Protection	Inbuilt
Over-Temperature Protection	135 °C

Dust and Water Protection	IP 65
Lightning Protection	Inbuilt

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

TESTING INSTRUMENTS AND MAINTENANCE KITS
OTHER TOOLS & PLANTS
&
FURNITURE

TESTING INSTRUMENTS AND MAINTENANCE KITS AND OTHER T&P'S & FURNITURE

TABLE OF CONTENTS

1. GENERAL

The testing and maintenance equipment covered here are generally meant for carrying out testing and measurement at site and shall be complete with all materials and accessories. These shall be robust in design, so that they give accurate results even in adverse site conditions.

All equipment furnished shall be of reputed make, type tested and shall be subjected to acceptance and routine tests in accordance with the requirements stipulated under respective equipment specification.

At least two sets of descriptive leaflets, catalogues, outline drawing, principles of operation etc. shall be sent along with the offer, for all the equipment offered. Weight and dimensions of items should also be mentioned.

Four sets of inspection and calibration report, operation and maintenance manual shall be sent along with Despatch documents. One set will be kept inside the equipment.

In the event of bidder offering equipment manufactured by different manufacturers, it will be his responsibility to fully co-ordinate the activities of each manufacturer in such a way that the complete equipment contracted for, is manufactured, supplied and guaranteed for successful operation.

2. TRAINING

Necessary training shall be provided to Employer's personnel for using and maintaining the equipment at Employer's premises.

3. CLIMATIC CONDITION

The equipment covered under this specification shall be suitable for operation under climatic condition stated else where in the specification. The offered equipment as such shall be suitable for satisfactory operation under the tropical climate.

3. 100 KV AUTOMATIC TRANSFORMER OIL BREAKDOWN VOLTAGE TEST SET

The equipment shall be suitable for operation at 240 volts 50 Hz. Single phase AC supply.

The BDV test kit shall be of automatic type and shall be as per IEC 156/95 as well as other international standards. This kit shall be operated through mains power supply and through battery.

The test set shall have the following feature & specification

- Lockable gap settings of electrodes for precision measurement.
- Automatic measurement of oil temperature with the help of built in temp. Sensor.
- Colour display with backlight.
- Test chamber shall be large fitted with oil drain for easy cleaning.
- High visibility test chamber
- Shall have dual redundant micro switch for safe operation.
- Voltage calibrator to be provided for checking of output voltage.
- The output voltage : 0-100 kV rms with an resolution of 0.1 kV
- Voltage measurement accuracy : 0-100 kV ± 1 kV
- Measurement of Oil temperature during testing : 0-100 degree centigrade
- Temperature resolution : 1° centigrade
- Switch over time on flash over : < 10 µS
- User can select various programs for testing
    - IEC 156/95
    - ASTM 1816-04-1/2/ASTM877-02A
    - EN60156

- Display : Bright LCD
- Power Supply: The equipment shall be suitable for operation at 240 volts 50 Hz. Single phase AC supply.
- **Guaranteed technical particulars for Transformer Oil BDV test kit:**

Sl No	Description	Yes / No
1	Specify the MAKE, Model, Details of accessories considered No and Country of Manufacturing.	
2	Whether the transformer oil BDV kit is microprocessor based	
3	The kit shall be portable with battery operated as well as mains operated.	
4	The output voltage is of 100 kV rms	
5	The feature accuracy and resolution are as per specification asked	
6	The kit shall be tested as per IEC 156/95 standards for testing of oil The kit shall consists of setting gauge of 2.5 mm	
7	The kit meets the GENERAL Technical specification of clause I.	
8	Technical data sheet, literature is enclosed along with the offer which is as per GTP	

4. 5KV AUTOMATIC INSULATION TESTER (MAINS & BATTERY OPERATED)

The microprocessor based kit is heavy Duty Battery& Mains Operated Insulation Resistance tester for power transformer to measure the insulation resistance automatically and shall able to display absorption index, Polarization index, DAR, Step Voltage and Dielectric Discharge test.

Technical Requirement.

1. Instrument shall be Mains and Battery operated.
2. Voltage Range 50V to 1KV in 10V steps, 1KV to 5KV/2.5 KV in 25 V steps
3. Resistance range : 10 KΩ to 15 TΩ.
4. Resistance range for each rated voltage shall be indicated in the offer. Instrument shall display direct reading of voltage across the test piece when the test is in progress.
5. Instrument shall display leakage current during measurement.
6. Short Circuit current **6mA**.
7. It shall have Breakdown or 'Burn' mode. Interference Rejection 1mA r.m.s per KV test voltage to a maximum 4mAr.m.s

8 Accuracy: Better than 2%; Noise Rejection Current: Min 6 mA and above.

9 Instrument shall have additional filter option for time constant selection

Test Time: Timer control & display facilities

Display: LCD 3 digit Digital /analog backlit display for resistance, voltage, leakage current, capacitance, battery status, timer constant and elapsed time of the test. Data Storage: On board memory min.32 KB

Capacity

Safety Standard : EN61010-1-:2001 CATIV 600 V

EMC Standard : EN61326-1: 1998 for use in heavy

Test set shall have high performance 'Guard terminal' for accurate measurement in presence of surface leakage.

Current Measurement : 0.01 nA to ±5 mA

Capacitance Measurement : 1 nF to 50 μF

Test time shall be selectable from 1 second to 99 minutes

Capacitor charging time shall be ≤ 5.0 Seconds per μF at 3mA

Capacitor discharge time shall be ≤ 5.0 Seconds per μF to discharge from 5000V to 50 V

Voltage Measurement range: 50 to 600V DC or AC; 0 to 5000 V DC when testing Instrument shall have high voltage warning display when input voltage across the terminal is above 50V.

Suitable calibrator shall be provided with the instrument.

Guaranteed Technical Particular (Insulation Tester)

Sl.no		YES / NO
1	Voltage selection – 50V to 1KV in 10V steps, 1KV to 5KV/ in 25 V steps	
2	Instrument shall be Mains and Battery operated	
3	Instrument shall measure the resistance range 10 KΩ to 15 TΩ.	
4	Instrument Shall have Short Circuit current 6mA and above	
5	**Insulation resistance range Digital** Digital display : up to 15 TΩ. Analogue display: up to 15TΩ.	
6	Instrument shall have Breakdown or 'Burn' mode	
7	Guard Terminal accuracy of 2% guarding 500K Ohm leakage with a 100M Ohm load	
8	The instrument shall performs automatic tests and measure Insulation Resistance, current, capacitance, Polarization Index, Step voltage tests, DAR & Dielectric Discharge.	
9	Does instrument has stable output source under low load condition? Does instrument provides 5KV output voltage even at 10Mohm load?	
10	Instrument shall measure Capacitance: up to 50 μF	
11	The kits accuracy and resolution is as per specification asked	

12	Suitable calibrator provided for calibration	
13	Does the kit offered is suitable for testing transmission line insulation in double circuit line ,when one line parallel to it in charged condition? If, No, Have quoted for line insulation measurement? Instrument offers 6ma and above noise current cancellation capability?	
14	Does the kit dependent on battery for its operation and testing?	
15	If, YES for point no 12, provided the details of battery?	
16	The kit meets the GENERAL Technical specification of clause I.	
17	The kit full fills safety, EMI/EMC compatibility for safe working at substation of equipment and human being.	
18	Technical data sheet, literature is enclosed along with the offer which is as per GTP	
19	What is instrument IP rating?(preferably better than IP65)	
20	CAT safety rating as per IEC1010-1:2001(shall be CATIV600)	
21	Specify the Make, Model , Details of accessories considered & Origin of Manufacturer of the equipment	

5. OIL SAMPLING BOTTLE

Oil Sampling bottles shall be suitable for collecting oil samples from transformers, for testing of the oils (BDV, Dissolved Gas Analysis, resistivity etc). Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

Oil sampling bottles shall be made of stainless steel having a capacity of 1 litre.

Oil sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

The design of bottle and seal shall be such that loss of hydrogen shall not exceed 5% per week.

An impermeable oil-proof, plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

6. RELAY TOOLS KITS (ALSO REFER THE SPECIFICATION OF PCM)

The relay test kit shall consist of the following minimum items:

1. Test plugs for use with testing equipment
2. Special type test plugs for using with modular type cases
3. Screw driver set with multiple fixing feature
4. Long nose pliers
5. Wire cutting pliers and stripper
6. Ordinary pliers
7. Adjustable wrench
8. Soldering irons of
    - Watts rating - 1 No.
    - Watts rating - 1 No.

- Watts rating - 1 No.

9. De-soldering pump

10. Printed Circuit Card-extender; Printed circuit card - `Puller' Suitable for all supplied relays

11. Test leads (Pair with 2 Mts. length) - 1 set

12. Shorting plugs, `pistol' prods (2 Nos.) - 1 set

7. SF6 GAS LEAK DETECTOR

The SF6 gas leak detector shall meet the following requirements

The detector shall be free from induced voltage effects.

The sensing probe shall be such that it can reach all the points on the breaker where leakage is to be sensed .Latest standard in this effect may be followed..

8. DIGITAL MULTI- METER

The Digital Multi-meter shall have high-precision 50,000 count or more DMM with all of the functions and features required for advanced testing in complex power and electrical applications.

The following measurement can be done by the digital multimeter:

DC Voltage, AC Voltage, DC Current, AC Current, Resistance, Frequency, Temperature, Capacitor, Duty

Cycle ratio, Decibel (dBV, dBm), Continuity Check, Diode Test, Low Power, Low Power, Measures

resistance.under low measurement current. Effective value (root mean square value) detection (RMS) and

mean value Detection (MEAN) can be switched during AC voltage or AC current measurement.

The kit shall have following characteristics:

a. 0.02% basic DC accuracy
b. Large display with 50,000 or more counts
c. Dual display for double indication for AC and DC, V and Hz, etc.
d. True-RMS Measurements AC and AC+DC
e. Wide AC Frequency bandwidth from 10Hz to 100kHz
f. True-RMS or MEAN value detection mode can be selected
g. Fast Peak Hold response time of 250µs
h. Low Power Ω for resistance measurements on sensible electronic circuits by a low and safe test current
i. User calibration function

The kit shall able to test parameters like Voltage, Current, Frequency, temperature, capacitance, and voltage detection, resistance, inductance, . The kit shall have following functions:

- Display : **50000**or more count, 5-digit display

- AC Voltage : 60 mV to 1000 V, 6 ranges
  - Basic accuracy: ±0.2 % rdg. ±25 dgt. (True RMS, crest factor 3)

- Frequency characteristics: 20 Hz - 100 kHz
  AC Current : 600 µA to 10A in 4 ranges
  - Accuracy: ±0.6 % rdg. ±5 dgt. (True RMS, crest factor 3)

- Frequency : AC V, DC+AC V, AC A measurement, at pulse width 1 µs or more (50 % duty ratio)

99.999 Hz (0.5 Hz or more) to 500.00 kHz, 5 ranges,

- Basic accuracy: ±0.005 % rdg. ±3 dgt. (True RMS, crest factor 3)

- DC Voltage :60 mV to 1000 V, 6 ranges
  - Basic accuracy: ±0.025 % rdg. ±2 dg
- DC Current :600.00 μA to **10A**, 4 / **6**ranges
  - Basic accuracy: ±0.6 % rdg. ±10 dgt.
- Resistance :Range-500 Ω to 4 MΩ
  - Accuracy: ±0.05 % rdg. ±5 dgt
- Capacitance : 1.000 nF to 100.0 mF, 9 ranges,
  - Basic accuracy: ±1.0 % rdg. ±5 dgt
- Continuity check: Continuity threshold: 20/50/100/500 Ω, Response time: 10 ms or more
- Diode check :Open terminal voltage: 4.5 V or less, Testing current 1.2 mA or less,
  - Threshold of forward voltage: 0.15 V to 3 V, seven stages
- dB level :Standard impedance setting (dBm), 4 Ω to 1200 Ω, 20 stages
- Temperature : K: -40.0 °C to 800.0 °C

  Add accuracy of the Thermocouple probe to main unit accuracy: ±0.5 % rdg. ±3 °C
- ±0.025% DC V basic accuracy, wide 20 Hz to 100 kHz AC V frequency characteristics
- Includes terminal shutter mechanism for accident prevention (prevents erroneous test lead insertion)

  Measures large currents with optional clamp probe
- USB communications function supports PC measurements shall be available.
- Broad -15 (5°F) to 55°C (131°F) operating temperature range.

Safety Features

- Complies with IEC 61010-1 CAT III , 1000V, CAT IV 600V
- Terminal shutter to prevent incorrect test leads' insertion in current terminals
- Overload protection of for voltage 1000 V DC / 1000 V rms AC
- Overload protection for current shall be given by fuse.

Guaranteed technical particulars for Digital Multimeter

Sr. No	Description	YES/NO/ REMARK
1	The Digital Multi-meter shall have high-precision 50,000 count or more DMM with all of the functions and features required for advanced testing in complex power and electrical applications.	
2	The following measurement can be done by the digital multimeter: DC Voltage, AC Voltage, DC Current, AC Current, Resistance, Frequency, Temperature, Capacitor, Duty Cycle ratio, Decibel (dBV, dBm), Continuity Check, Diode Test, Low Power, Low Power, Measures resistance .under low measurement current. Effective value (root mean square value) detection (RMS) and mean value Detection (MEAN) can be switched during AC voltage or AC current Measurement.	
3	The kit shall have following characteristics: a. 0.02% basic DC accuracy b. Large display with 50,000 or more counts c. Dual display for double indication for AC and DC, V and Hz, etc.	

	d. True-RMS Measurements AC and AC+DC e. Wide AC Frequency bandwidth from 10Hz to 100kHz f. True-RMS or MEAN value detection mode can be selected g. Fast Peak Hold response time of 250µs h. Low Power Ω for resistance measurements on sensible electronic circuits by a low and safe test current i. User calibration function	
4	AC Voltage: 60 mV to 1000 V, 6 ranges Basic accuracy: ±0.2 % rdg. ±25 dgt	
5	Frequency characteristics: 20 Hz - 100 kHz AC Current: 600 µA to 600 mA,10A Accuracy: ±0.6 % rdg. ±5dgt.	
6	Frequency: AC V, DC+AC V, AC A measurement, at pulse width 1 µs or more (50 % duty ratio) 99.999 Hz (0.5 Hz or more) to 500.00 kHz, 5 ranges, Basic accuracy: ±0.005 % rdg. ±3 dgt.	
7	DC Voltage:60 mV to 1000 V, 6 ranges Basic accuracy: ±0.025 % rdg. ±2 dgt.	
8	DC Current:600.00 µA to 600.00 mA/ 10A, 4 / 6ranges Basic accuracy: ±0.05 % rdg. ±5 dgt. / ±0.6 % rdg. ±10 dgt.	
9	Resistance:Range-500 Ω to 4 MΩ Accuracy: ±0.05 % rdg. ±5 dgt	
10	Capacitance: 1.000 nF to 100.0 mF, 9 ranges, Basic accuracy: ±1.0 % rdg. ±5 dgt	
11	Continuity check: Continuity threshold: 20/50/100/500 Ω, Response time: 10 ms or more	
12	Diode check: Open terminal voltage: 4.5 V or less, Testing current 1.2 mA or less	
13	Threshold of forward voltage: 0.15 V to 3 V, seven stages , dB level :Standard impedance setting (dBm),	
14	Temperature : 0 °C to 800.0 °C	
15	Technical data sheet, literature is enclosed along with the offer which is as per GTP	
16	Pls. mention the type of battery required for operation	
17	Specify the Make, Model, Details of accessories considered & Origin of Manufacturer of the equipment	

9. DIGITAL CLAMP METER (TRUE RMS AC/DC)

Instrument shall have following feature and technical specification
(True RMS AC/DC Digital clamp Meter)

Technical Specifications

AC current

	100.0/1000A (45Hzto66Hz:±1.5%rdg.±5dgt.)
AC voltage	0-750Voltage ((±1.3%rdg.±5dgt.)
DC current	100.0/ 1000A (±1.5%rdg.±5dgt.)
DC voltage	0-1000V (±1.3%rdg.±4dgt.)
Resistance	0-40Mohm (±2.0%rdg.±4dgt.)
Continuity	420 ohm (±2.0%rdg.±6dgt.) Threshold level : Less than 50W ±40ohm (Buzzer sound)
AC measurement	MEAN value(3288) / True RMS(-20)
Maximum rated voltage to earth	CAT iV 600V
Display update rate	400ms ±25ms
Range switching	Auto range/ Manual range
Zero suppression	5 count or less (current measurement only)

Safety Features

- Complies with IEC 61010-1 CAT III , 1000V, CAT IV 600V
- Terminal shutter to prevent incorrect test leads' insertion in current terminals
- Overload protection of for voltage
- Overload protection for current shall be given by fuse

Guaranteed technical particulars for True RMS AC/DC Digital clamp Meter

Sl No	Description	Yes/No
1	The kit shall measure averaging/true RMS reading of current and voltage	
2	Range of AC current measurement: 400mA, 4A, 30A	
3	Range of DC current measurement: 4A, 30A	
4	The accuracy and resolution is as per specification.	
5	Jaw opening size is 23 mm	
6	Technical data sheet, literature is enclosed along with the offer which is as per GTP	
7	Pls. mention the type of battery required for operation	
8	Specify the Make, Model , Details of accessories considered & Origin of Manufacturer of the equipment	

10. DIGITAL EARTH RESISTANCE TESTER

The kit shall be microprocessor-controlled with self-diagnostic features. This instrument shall be portable 3 &1/2 digits, Digital earth meter and is suitable to measure earth resistance, specific ground resistivity.

This features automatic control system of injected current & an alarm warning that the current is not enough in order to achieve a reliable measurement. This meter is powered up by in built chargeable battery.

Measurement range is 0.01 Ω to 2 k Ω. It Shall be able to measure resistance of single and multiple electrodes mesh system, plates, earth strips etc. and resistivity by four pole method, in up to 400 KV A.C switch yard under energized conditions.

Earth Tester is a digital automatic Earth Resistance meter that allows measuring Earth Resistance by 2 Pole, 3 pole and 4 pole methods. It shall also able to measure soil resistivity through 4 wire measurement. The test current shall be minimum 40 mA.

The measurement frequency shall be in various selections of more than 60 Hz & up to 1500 Hz and the test current shall be minimum of 40 mA.

The kit shall able to work in the charged switchyard condition of 400 kV.

The following indication and precautions shall be given by the equipment.

1. A sharp and intermittent audible signal indicates anomalies in the circuit.
2. It shall be Immunity to Interference: The operation frequency will not coincide with any harmonics of the industrial frequency in order to minimize the effect of parasitic currents present in the surveyed soils. Suitable arrangement shall be incorporated in the instrument to take care of immunity system.
3. Measurement ranges: 2, 20; 200;2000
4. Accuracy: minimum ±2%
5. Battery status checking: Possible to verify the battery charge status under normal use Conditions.
6. Audible Alarm: Warning signal for any abnormalities.
7. The kit shall able to display resistance of auxiliary rod, frequency of test current, voltage and Frequency of interference (noise) residual resistance
8. The kit shall be supplied with following accessories:
   a. 4 Auxiliary electrodes(50cm long Augur style spikes),
   b. Hexagonal shape, Galvanized steel, 1 rod extraction tool(if required),
   c. A.C Adapter for the battery charger (universal type),
   d. Connection cable: 40 mtrs red lead,40 mtrs blue lead, 20 mtrs green lead,20 mtrs black lead, 5 mtrs green lead (earth electrode)etc,4 mm shrouded plug and large croc clip,50mtrs measuring tape, carry case and any other materials /leads required to be supplied along with the instruments.
   e. Necessary clamp for measurement in 2 pole methods.

The kit shall possess following safety and applicable standards:

- IEC 61010-1 , IEC – 61010-031, IEC 61557-1.5, IEC 61326
- CAT-III300V,CAT IV 150V

Guaranteed Technical Particular (Earth Resistance Tester)

Sl. NO	**Description**	**YES / NO**
1	Equipment is microprocessor based.	
2	Equipment is self-diagnostic features & alpha numerical display.	
3	Battery operated (rechargeable)	

4	Earth resistance range and accuracy as per specification	
5	Measurement Frequency shall be as per specification	
6	Accessories as per specification.	
7	Test current- Minimum 40 mA and test frequency from any of these or in various selections of more than 60 Hz & up to 1500 Hz.	
8	Measures earth resistance in 2 pole, 3 pole and 4 pole method	
09	The kit meets the GENERAL Technical specification of clause I.	
10	The kit full fills safety, EMI/EMC compatibility for safe working at substation of equipment and human being.	
11	Specify the Make, Model, Details of accessories considered & Origin of Manufacturer of the equipment	

11. Discharge Rods:

Discharge rods shall be good quality and as per the latest relevant standard. Required length of PVC good insulation flexible copper cable, required clamp connected at the end of wire shall be connected. The top portion of the discharge rod shall be adjustable to fit in for proper gripping by screwing from the bottom side. The entire handle shall be of latest insulating materials for the safety of the user. The discharge rod shall be reliable, durable and shall meet the safety requirement of the users.

12. Rubber Hand Gloves:

Good quality rubber gloves for using during operation of isolators and earth switch. Latest standard for the rubber gloves shall be followed. The gloves shall be reliable, durable and shall meet the safety requirement of the users.

13 Portable Emergency Light:

Reputed make (BPL/CGL/Bajaj) portable emergency light, having twin tube, shall be supplied to each sub-station. It shall have chargeable battery (durable) and having provision of selection switch for selecting single or double tube. It shall have chargeable feature during not in use and automatically switch on in the event of power failure. CFL tubes are preferred. It shall have provision of wall hanging/table mounting and shall be durable one. Latest standard in this effect shall be followed.

14. SCHEDULE OF REQUIREMENTS OF MAINTENANCE TESTING EQUIPMENT

ANNEXURE – I

Item nos.	**Units**	**ALL 132/33KV**	**ALL 220/132/33 KV S/S**	**220/33 KV S/S**
100 kv automatic transformer oil breakdown voltage test set	Nos	1	1	1
Insulation resistance tester (megger)	Nos	1	1	1
Oil sampling bottle	Nos	4	4	4
SF6 gas leak detector	Nos	1	1	1
LCD, digital multimeter	Nos	2	2	2
LCD, clamp on meter	Nos	2	2	2
Digital earth tester	Nos	1	1	1

Discharge rod as per standard for carrying out the switch yard maintenance work	Nos	6	6	6
Rubber gloves of operation of isolators and earth switch	Pairs	2	2	2
Relay tools kit	Sets	1	1	1
Portable emergency light	Nos	4	4	4
Latest version desktop PC of reputed make with all its accessories including CPU, Monitor, UPS and having all latest loaded software and also its back up in shape of CD and separate pen drive . suitable for loading of software as recommended by the relay manufacturer. It includes supply of one no portable laser printer of reputed make. Make of PC and printer: HP/DELL	Set	1	1	1

** The above equipments shall be of reputed make confirming to the technical specification. Prior approvals of OPTCL for all the testing equipments are to be taken.

15. OTHER TOOLS AND PLANTS (T&P'S) REQUIREMENT:

(ANNEXURE- II)

Following T&P's of reputed make are also in the scope of this contract.

Sl No	Description of Items	unit	Quantity against Each Package		
			ALL 132/33 KV	**ALL 220/132/33 KV S/S**	**220/33 KV S/S**
1	Set of "D" spanner(6mm – 42mm)	Set	1	1	1
2	Set of "Ring" spanner(6mm – 42mm)	Set	1	1	1
3	Socket wrench with sockets,handles,and other attachment(6mm-42mm)	Set	1	1	1
4	Insulated cutting plier	Nos	2	2	2
5	Insulated nose plier	Nos	2	2	2
6	Monkey plier	Nos	1	1	1
7	Circlip plier	Nos	1	1	1
8	Pipe wrench a)12 inch – 1 no b)18 inch – 1 no	Set	1	1	1
9	Sly wrench		1	1	1

	a)12inch – 2 nos b)18inch – 1 no	Set			
10	Insulated handle screw drivers of different sizes as per required a)12inch plain head – 2 nos b)8inch plain head – 2 nos c) 12inch star head – 1 no d) small size6inch plain and star head – 2 each e)Complete set of different head in one box/set -1set	Set	1	1	1
11	"L"-N keys set of different sizes in one box/set	Set	1	1	1
12	M.S Files(12inch and 6inch sizes) Round files and flat files-one each of different sizes)	set	1	1	1
13	Hammar with handle a)1 lb – 2 nos b)1/2 lb-2 nos c)2 lb-1 no	Set	1	1	1
14	Crow bar a)5 ft – 2nos b)3ft-2 nos	set	1	1	1
15	Steel scale(12inch)	Nos	2	2	2
16	Steel tape a)5 mtrs-2 nos b)30mtrs-1 no	Set	1	1	1
17	Oil cane	Nos	2	2	2
18	Spirit level (8inch)	No	2	2	2
19	Plumb head with string and attachment	No	1	1	1
20	Maintenance safety belt with all attachment and helmets(complete one set)	Set	3	4	3
21	Hand drill machine with different bits and key.(Wolf make)	No	1	1	1
22	Vacuum cleaner having hot blower provision with all attachments (Eureka Forbes make)	No	1	1	1

23	230-250VAC,80W,450mm sweep,1400 rpm stand(rugged) FAN Make: Almonard,CGL	No	2	4	2

** All the T&P's shall be of Taparia make. The hand drill and vacuum cleaner shall be wolf and Eureka Forbes make.

16. OFFICE FURNITURE:

Supply and installations of the office furniture are in the scope of this contract. All the furniture shall be of Godrej & Boyance make. Before supply of the furniture to the sub-station, approval from OPTCL is required. Details of the scope of supply are as indicated below.

ANNEXURE – III.

Sl No	Description of Items	unit	Quantity against Each Package		
			ALL 132/33 KV	**ALL 220/132/33 KV S/S**	**220/33 KV S/S**
1	5ftX3ft executive table with drawer both sides	Nos	5	6	5
2	3ftX2&1/2ft Table with one side drawer	Nos	7	8	7
3	Computer table suitable keeping monitor,CPU,UPS and printer with two nos revolving arm chair suitable for computer use.	Set	1	1	1
4	Executive revolving ,adjustable(height) chairs with arm	Nos	5	6	5
5	Cane gutting "S" type steel chairs with arm	Nos	18	24	18
6	6ftX3ft conference table	Nos	1	1	1
7	Cushion arm steel chairs for conference table purpose	Nos	6	8	6
8	6ft height steel almirah (only with selves) for keeping records and other valuable items	Nos	4	6	4
9	6ft height steel almirah with glass doors for library purpose	Nos	2	2	2
10	6ft height (having minimum 6 lockers facility) steel cupboard with locking arrangement	Nos	2	2	2
11	4ft steel rack (minimum three selves) for keeping the files and other items	Nos	8	10	8